

THE
IMPORTANT TIMBER TREES
OF THE UNITED STATES

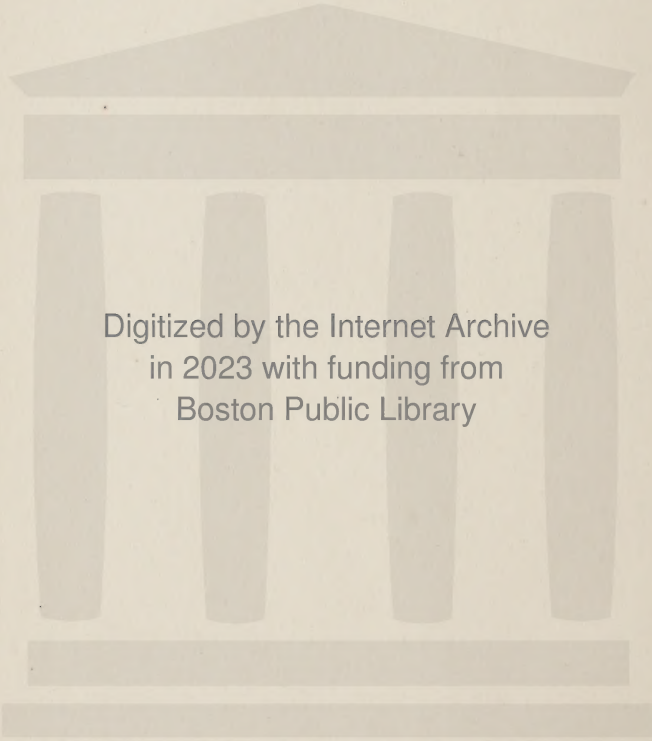
BY SIMON B. ELLIOTT

REFERENCE LIBRARY * HOUGHTON MIFFLIN CO. * BOSTON, MASS.

*Archive
Collection*



* This book may not leave the Offices
and if borrowed must be returned within 7 days *



Digitized by the Internet Archive
in 2023 with funding from
Boston Public Library

THE IMPORTANT TIMBER TREES
OF
THE UNITED STATES



VIRGIN FOREST OF BALD CYPRESS GROWING IN SWAMP
Note conical "knees" and buttressed base of trees. — *Copyrighted by*
Clark L. Poole & Co., Chicago, Illinois.

THE IMPORTANT TIMBER TREES OF THE UNITED STATES

A MANUAL OF PRACTICAL FORESTRY

FOR THE USE OF
FORESTERS, STUDENTS AND LAYMEN IN
FORESTRY, LUMBERMEN, FARMERS AND
OTHER LAND-OWNERS, AND ALL WHO
CONTEMPLATE GROWING TREES
FOR ECONOMIC PURPOSES

BY

SIMON B. ELLIOTT

*Member of the Pennsylvania Forestry Reservation
Commission and Associate Member of the
Society of American Foresters*



BOSTON AND NEW YORK
HOUGHTON MIFFLIN COMPANY

The Riverside Press Cambridge

1912

COPYRIGHT, 1912, BY SIMON B. ELLIOTT

ALL RIGHTS RESERVED

Published April 1912

To the Memory of my Wife
I Dedicate this Book

PREFACE

THE sincere but mistaken belief that our forests were inexhaustible was quite a natural one. Such a conclusion arose from their vast extent and vigorous growth, and when a cry for their protection and conservation was heard, it was, at first, deemed but a repetition of the cry of "Wolf!" in the fable, and was unheeded. In the beginning the cry was very faint and apparently far away; but it grew louder and nearer as the danger of irreparable disaster became more imminent, and we now hear it in strong voice and on every hand. As this awakening to the impending danger has become widespread, there arises in the public mind a strong and earnest desire to know (1) whether the productive capacity of the forests of our country is adequate to meet the demands which will inevitably be made upon them; and, if not, (2) whether any system of conservation which will make it adequate can be devised and applied. Moreover, the public desires to know (3) whether planting new forests on non-agricultural land, where the axe of the lumberman and successive fires have destroyed all valuable tree-growth, is practicable; and, if so, (4) what species of trees would best be grown, where they should be planted, and how they can best be propagated and cared for.

A comprehensive answer to the first two of these inquiries must take cognizance of the condition of existing forests and, likewise, their possible future productive capacity. Such answer should show whether we are consuming our forests faster than they grow; and whether, under any system of forest management, they can be made to meet such future demands as the inevitable increase of population and new uses for forest products are sure to bring about. And the answer to the last two will, necessarily,

comprise and set forth the details of what may best be termed Practical Forestry. The question how well I have met these inquiries is submitted to the judgment of those who will peruse the following pages.

My endeavor has been to make the work a Manual of Practical Forestry, — indulging in theory no more than is necessary to show the basis upon which theory rests. It is not claimed that a study of this volume will make a fully equipped forester; for a study of no one book nor of all books can alone do that. The impossible has not been attempted. A fully endowed forester must have both a theoretical and a practical knowledge of all matters pertaining to tree-life, and to this should be added broad experience and large opportunities for observation, covering the restoration, productivity, harvesting, care, and perpetuation of forests grown and maintained for economic purposes. The average person who may desire to grow trees for such use cannot devote the necessary time to acquiring as full a knowledge of the science of forestry as the expert must possess. Such a course would, for him, be impracticable. It is claimed, however, that by a careful study of the contents of this volume one may, with the exercise of good judgment, successfully grow trees for economic purposes without being compelled to call in the services of a trained expert, or without being forced to roam through the domain of botany, dendrology, and silviculture, or to master mensuration, stem analysis, or other purely technical features of scientific forestry. Not that experts possessing such knowledge are unnecessary, for they are necessary, and the country cannot do without them any more than it can dispense with the services of highly educated men in agriculture, or any other line of industry on which the welfare of our country depends. But the average successful farmer does not have to depend wholly upon experts in agriculture successfully to carry on his farming operations, although he may and should be guided by their teachings. Neither should he, when he essays to grow trees for his own use, be

compelled to call in the services of an expert in forestry ; nor should any landowner, when he desires to reclothe his denuded lands with valuable species of trees, be unable intelligently to direct such work.

Technical terms are avoided wherever possible, but are absolutely necessary to identify the several species, for nearly all of our valuable timber trees are loaded with numerous local common names,— some have more than a score, —and identification would be impossible without the use of a scientific name which has been established by usage and common consent and adopted by all recognized authorities. A glossary of all these terms will be found in the Appendix, on a page devoted to that purpose. In giving the common and scientific names of the several species of trees which are considered worthy of consideration, I have followed the *Check List of the Forest Trees of the United States*, by George B. Sudworth, Dendrologist of the United States Forest Service, as the one which should be accepted as a standard of authority. In no other case is a technical term used where there is a substitute, and where there is no substitute the meaning of the term is explained.

Perusal will disclose the fact that the main purpose of this volume is to urge, aid, and encourage tree-growing for economic purposes only, and it is more than probable that the reader will ask why certain species now being largely used have been deemed of enough importance to be described at length and yet are not recommended for cultivation. The answer is that the forests of the future must be largely grown with planted trees, and there is no reason why we should plant or in any wise grow any but the most suitable and valuable ones — those that will produce the best and most needed forest products in the shortest time, and with the least labor and expense ; and such only have been recommended. We now accept less valuable species because they are present with us and they have cost us nothing to grow. Hereafter it will cost both money and labor and require much time to grow forests, and in the

not distant future the price of forest products will be based upon the cost of production. If White Pine, which is easily propagated, will grow to be a merchantable tree in seventy-five years, and a Hemlock, which can be grown with difficulty, will require from one hundred and twenty-five to one hundred and fifty years to reach the same dimensions, and the product of the Pine be worth twice that of the Hemlock, it should be known, and when known there would be no question as to which should be planted. It is sometimes a good thing to know what not to do, and we cannot determine which species are best adapted to cultivation unless we know the habits, character, and comparative value of each. There are enough valuable species to choose from and there is no reason why we should choose any but the very best, always keeping in mind the demands of the market, the uses the wood can be put to, the adaptability of the tree to the soil, climate, and location, and the rapidity of growth and facility of production.

Another feature may cause surprise in the minds of some of my readers. It is not at all improbable that some of the descriptions of trees considered do not agree with the reader's personal observation, and yet such descriptions may well fit the general average of the tree. The character and general appearance of trees are frequently modified to a great extent by location, climate, and soil. Trees of a given species grown in the same vicinity will often vary in form and sometimes in character of wood; therefore a description of the general average will best fit the case, and to give such has been my endeavor.

Much time and labor have been spent in the preparation of this work, and while it is largely drawn from my own personal observations I feel myself greatly indebted to the aid which others have generously given me. I would gladly here publicly recognize the work of each, but they are too numerous, and I content myself with the personal acknowledgments which I have given by letter or otherwise. I have endeavored to give due credit to all authors from

whom I have consciously copied. Such recognition will be found in its appropriate place. I must not fail, however, to recognize here the value of the services and courtesies extended to me by the Forest Service of the United States, through its able dendrologist, Mr. George B. Sudworth, and also to extend grateful acknowledgments for the use of many of the photographs here shown, due credit being given on each. I take great pleasure in expressing my gratification at the approval and suggestions of Professor F. W. Rane, State Forester of Massachusetts, to whom was submitted the manuscript before it was placed in the hands of the publishers. Professor Rane's approval is of moment, as it comes from one of the most practical foresters in the country.

S. B. E.

REYNOLDSVILLE, PENNSYLVANIA,
April, 1912.

CONTENTS

PART I

I. INTRODUCTORY	3
II. PRESENT CONDITION OF THE FORESTS	8
III. RESTORATION AND TREATMENT OF FORESTS	14
IV. ARTIFICIAL RESTORATION	22
V. FOREST DEMANDS.	31
VI. DIFFICULTIES OF REFORESTATION	38
VII. PLANTING THE FOREST	43
VIII. WHERE AND WHAT TO PLANT	49
IX. WHEN TO HARVEST	53
X. THE WOODLOT	58
XI. LIFE-HISTORY OF A TREE	63
XII. CLASSIFICATION AND CHARACTER OF WOOD	79
XIII. THE FOREST NURSERY	87
XIV. THE TRANSPLANT NURSERY	111
XV. HOW TO CARE FOR AND WHEN TO SOW FOREST SEEDS	115
XVI. TAP-ROOT.	119
XVII. WHEN TO PLANT TREES IN THE FOREST	121
XVIII. SPACING TREES IN THE FOREST	123
XIX. WILL PLANTING FORESTS EVER BECOME PROFITABLE?	126

PART II

THE PINES	133
THE SPRUCES	178

THE FIRS	189
THE EASTERN FIRS	189
THE WESTERN FIRS	191
DOUGLAS FIR	199
THE HEMLOCKS	203
RED CEDAR	207
WHITE CEDAR	210
WESTERN RED CEDAR	213
BALD CYPRESS	215
THE LARCHES	219
THE SEQUOIAS	226
THE OAKS: WHITE OAK CLASS	231
RED OAK CLASS	247
THE ASHES	258
THE HICKORIES	268
THE MAPLES	276
YELLOW POPLAR	283
CHESTNUT	286
BLACK CHERRY	291
THE ELMS	296
BASSWOOD	302
THE BIRCHES	306
BEECH	310
BLACK WALNUT	313
BUTTERNUT	317
LOCUST	319
HONEY LOCUST	323
CUCUMBER	326

CONTENTS

xv

SYCAMORE	328
THE COTTONWOODS	332
THE GUMS	338
THE CATALPAS	344
EUCALYPTUS	348
BROADLEAF TREES OF THE PACIFIC SLOPE	351

APPENDIX

GLOSSARY OF SCIENTIFIC NAMES OF SPECIES OF TREES . .	361
AVERAGE HEIGHT OF SEEDLINGS	364
APPROXIMATE PERCENTAGE OF GERMINATION OF TREE SEEDS	366
NUMBER OF TREE SEEDS PER OUNCE AND POUND, ETC. . .	367
INDEX	369

ILLUSTRATIONS

VIRGIN FOREST OF BALD CYPRESS GROWING IN SWAMP	<i>Frontispiece</i>
DESTRUCTIVE LUMBERING, ELK COUNTY, PENNSYLVANIA . . .	6
RED PINE, FOREST-GROWN, STANDING ON NORMAL SCHOOL GROUNDS, MARQUETTE, MICHIGAN.	6
VIRGIN FOREST OF WHITE PINE, CLEARFIELD COUNTY, PENN- SYLVANIA	14
CHARACTERISTIC VIEW IN THE WIENER-WALD, AUSTRIA . .	24
VIEW IN THE FOREST OF PRINCE BISMARCK, FRIEDRICHSRÜHE, GERMANY, SHOWING COMPARTMENT LINE, WHICH SERVES AS FIRE LINE AND ROAD.	40
AN OLD PLANTATION OF SPRUCE NEAR EISENACH, GERMANY	40
SECOND-GROWTH WHITE PINE, ABOUT THIRTY YEARS OLD, JEFFERSON COUNTY, PENNSYLVANIA	54
SEEDLING WHITE ASH, ONE YEAR OLD, SHOWING DEVELOP- MENT OF TAP-ROOT	64
SPRAY AND STAMINATE BLOSSOMS OF WHITE PINE . . .	64
DEVELOPMENT OF WHITE PINE SEEDS	64
SECTION OF A WHITE PINE BOARD, SHOWING ANNUAL RINGS	72
SECTION OF A JOIST CUT FROM OLD-FIELD PINE, SHOWING MARKED DIFFERENCE BETWEEN SPRING AND SUMMER WOOD	72
SECTION OF RED OAK, SHOWING MEDULLARY RAYS AND AN- NUAL RINGS	72
SECTION OF CAROLINA POPLAR, SHOWING ANNUAL RINGS, IN- TERMEDIATE RINGS CAUSED BY ALTERNATE WET AND DRY WEATHER, AND IRREGULARLY SHAPED HEARTWOOD . .	72

SECTION OF WHITE ASH, SHOWING EFFECT OF LACK OF AIR AND MOISTURE FOR ROOTS ON ONE SIDE	72
NATURALLY GROWN WHITE PINE SEEDLINGS, SHOWING LACK OF FIBROUS ROOT DEVELOPMENT	88
NURSERY-GROWN WHITE PINE SEEDLINGS AND TRANSPLANTS, SHOWING GOOD ROOT DEVELOPMENT	88
PENNSYLVANIA STATE FOREST NURSERY, ASAPH, PENNSYLVANIA, SHOWING LATH SCREENS OVER SEEDLINGS	96
WHITE ASH IN THE EXPERIMENT FOREST PLANTATION AT THE STATE UNIVERSITY, CHAMPAIGN COUNTY, ILLINOIS	96
TEN-YEAR-OLD WHITE PINE PLANTING NEAR MONT ALTO, ON PENNSYLVANIA STATE FORESTRY RESERVATION. WORK OF STUDENTS OF THE PENNSYLVANIA STATE FOREST ACADEMY	136
TYPICAL IDAHO FOREST, SHOWING WESTERN WHITE PINE, LARCH, AND CEDAR, KANIKSU NATIONAL FOREST.	146
SUGAR PINE, KINGS RIVER, FRESNO COUNTY, CALIFORNIA	146
ROUND, OR UNTAPPED, TIMBER. VIRGIN FOREST OF LONGLEAF PINE, OCILLA, GEORGIA	154
LOBLOLLY (OLD-FIELD) PINE, SHANNON COUNTY, MISSOURI	160
SHORTLEAF PINE, SHANNON COUNTY, MISSOURI	160
VIRGIN FOREST OF WESTERN YELLOW PINE AND DOUGLAS FIR NEAR MOUNT SHASTA, CALIFORNIA	170
SCOTCH PINE IN DENSE STAND ON CAMPUS, IOWA STATE COL- LEGE, AMES, IOWA	176
DOUGLAS FIR, SHOWING TREES MORE THAN SEVEN FEET IN DIAMETER. WESTERN WASHINGTON	200
VIRGIN STAND OF WHITE PINE AND HEMLOCK, WITH SECOND GROWTH OF EACH COMING ON WHERE ORIGINAL FOREST WAS CUT OFF. CLEARFIELD COUNTY, PENNSYLVANIA	204
VIRGIN STAND OF HEMLOCK, FROM ONE HUNDRED AND FIFTY TO TWO HUNDRED YEARS OLD, TIOGA COUNTY, PENNSYLVANIA	204

BALD CYPRESS, NOT OVER SEVENTY-FIVE YEARS OLD; TWENTY-NINE INCHES IN DIAMETER SIX FEET ABOVE THE GROUND AND EIGHTY-FOUR FEET HIGH. STATE CAPITOL GROUNDS, HARRISBURG, PENNSYLVANIA	216
BIG TREES, WITH SUGAR PINE, WESTERN YELLOW PINE, AND WHITE FIR, SIERRA NEVADA, CALIFORNIA	226
WHITE OAK, FOUR FEET IN DIAMETER, NEARLY FIFTY FEET TO FIRST LIMB, FOX ESTATE, CLARION COUNTY, PENNSYLVANIA	234
BIG BURR OAK, GIBSON COUNTY, INDIANA. CIRCUMFERENCE ABOVE SWELL, TWENTY-TWO FEET	242
RED OAK, FOUR FEET IN DIAMETER AND MORE THAN FORTY FEET TO FIRST LIMB. JEFFERSON COUNTY, PENNSYLVANIA	248
GROUP OF HICKORIES : <i>Hicoria glabra</i> AND SHAGBARK. MONTEREY, PUTNAM COUNTY, TENNESSEE	270
SUGAR MAPLE	278
YELLOW POPLAR (TULIP-TREE), FOREST-GROWN, FORTY INCHES IN DIAMETER, JEFFERSON COUNTY, PENNSYLVANIA	284
TULIP-TREE, GROWN IN THE OPEN, SIX FEET IN DIAMETER, MONASKON, VIRGINIA	284
CHESTNUT	288
BLACK CHERRY, NORTH CAROLINA	292
WHITE, OR GRAY, ELM, CHARLEVOIX COUNTY, MICHIGAN	296
BASSWOOD	302
BEECH	310
CUCUMBER, NEARLY FIVE FEET IN DIAMETER, IN VIRGIN FOREST, JOHN E. DUBOIS ESTATE, ELK COUNTY, PENNSYLVANIA	326
SOUTHERN HARDWOOD FOREST, MAINLY RED GUM	342

PART I

THE IMPORTANT TIMBER TREES OF THE UNITED STATES

I

INTRODUCTORY

No one can truthfully deny that we have reached a critical period in our country's industrial progress. We have, in the past, been loath to believe that we were even approaching such a period, for we have indulged in the belief—and many still hold to that faith—that our natural resources are inexhaustible. Observing men, however, know that such a conclusion is very far from fact, and realize that in our rapid advance in material progress we shall soon be face to face with the practical exhaustion of our important natural resources; and they further realize that we must do something to conserve and, as far as possible, restore such resources or we shall, ere long, be overwhelmed with irreparable disaster.

Fortunately many of our people are now beginning to see the absolute necessity for conservation and they are fast coming to a knowledge of the fact that, of all the resources which we now enjoy,—and of which we have heretofore thoughtlessly boasted,—only such as arise, in some form, from the cultivation or use of the soil can be renewed when once exhausted. It is now becoming well understood that the time will come, and in the not far distant future, when our coal, oil, gas, and other valuable minerals will be either completely exhausted or so near that condition as to make their acquisition difficult and expensive. It is being further comprehended that, like other products of the soil, the forests which we still possess can, with proper manage-

ment, be maintained in useful perpetuity, and in many cases their productive capacity be increased, and that while we are consuming their annual accretion we need not necessarily exhaust them; and, what is equally important, it is likewise realized that forests can be grown in practically all sections of our country where, in our early history, they once grew but have since been destroyed, and also even where there is no proof that any have ever existed. These facts give vital and commanding importance to that heretofore neglected feature of our national welfare known as "Practical Forestry," a feature which is second only to agriculture and one which hereafter must go hand in hand with that industry.

It is gratifying to know that there is a growing conception of the actual facts relating to our forest conditions, notwithstanding that they reveal a most deplorable state. We have come to understand that our present forests will no longer be capable of producing the vast amount of useful products which will be demanded of them. We have learned from statistics obtained by governmental effort that we are consuming our forests more than three times as fast as they grow,¹ and we well know what, if not arrested, that will lead to. It is largely realized, too, that many new uses for forest products have recently sprung up, and that, through these new uses and the rapid increase of population in our country, the future demands for forest products will inevitably be greatly increased; and all must see that if such demand cannot be promptly and fully met the index hand on the dial of progress of this nation will advance no further, but, instead, go backward.

¹ "It has been shown that the present annual cut of forest products requires at least twenty billion cubic feet of wood. To produce this quantity of wood without impairing the capital stock, over seven hundred million acres of forest must make an annual increase of thirty cubic feet per acre. Under present conditions of mismanagement and neglect it is safe to say that the average annual increment is less than ten cubic feet per acre for the entire area. This means that each year's cut, at the present rate, takes the growth of more than three years."—*United States Forest Service Circular*, No. 97, page 14.

A comprehension of all this, and more, is surely finding a lodgment in the minds of the American people; and the fact is fast being realized that the thought expressed by President Roosevelt—when he declared, in substance, that the forest problem is the most important one before us for solution—was not only true in every sense of the word but was timely uttered. The growing shortage of our supply of forest products, the rapidly increasing demands for such products, our cut-over, burned-over, and fast-becoming-barren lands, the disturbed flow of our springs and streams, and the erosion of the soil that is going on in consequence of the destruction of the forests, are conditions patent to all; and these conditions, though vocally silent, convey to us, in a language that we cannot fail to understand, the importance of action on our part. They all point to the same conclusion,—that the forests should be restored at the earliest possible moment.

The duty of the hour can be summed up in one sentence: a supply of forest products must be maintained by properly caring for what forests are left us and by planting others where necessary to meet the demand. If we do not do this the end of our nation's prosperity will soon be reached. Every day's delay adds to the difficulties to be encountered.

How to care for our forests, how to increase their productive capacity, and how to grow new ones are, unfortunately, problems not so well understood by the people of this country as they should be; but they must be solved. Few have given the subject—more properly the science, for forestry is a science—the careful, intelligent study that its importance demands. To the average citizen forestry is as a “sealed book.” He knows not what is demanded; but such lack of knowledge is not to be wondered at. Until recently there has not been felt a necessity for its study. Nature had bounteously provided us with all the trees that we supposed we needed, and it has been believed, and still is believed by many, that she can be depended upon to con-

tinue in that work, — and so she could and would have done had we not interfered. But we have seriously and disastrously interfered. Over vast areas we have destroyed her seed trees and burned up her young growth. Instead of encouraging forest reproduction we have thoughtlessly and in many cases maliciously, prevented it. All this must come to an end, and it will in time, but there is great danger that it will not until dire necessity compels it.

Those having faith that we shall ere long take up the good work of reforesting our once productive but now barren timber lands naturally turn to see what other people have done in that line; and the first thought goes out to such European countries as have now attained great success in growing productive forests. Now, it is true that we can learn much from their experience, but it is equally true that we must largely depend upon ourselves, for our species of trees, our climatic conditions, and, largely, our soil, differ from theirs. So far as forest conditions go, we practically now stand where European nations stood two hundred and fifty or three hundred years ago, and of their experience in reforestation we can make use; but, like them, we must build from the bottom up, taking from the experience of others such practices as may be found adapted to our conditions.

Realizing all this, the author of this volume has, in the following pages, given the results of more than half a century's arduous, earnest, and painstaking study and observation of forests and forest growth which prevail in this country, both as a student in forestry and as a practical lumberman of large experience, to which is added personal observation of some of the best European forests and an experience of more than seven years as a member of the Pennsylvania Forestry Reservation Commission. This study and experience has forced upon him the conclusion — and it is positive — that the principal effort in forestry in this country must, for the next sixty or seventy years, be directed to tree-growing, and that such tree-growing must mainly be



DESTRUCTIVE LUMBERING: LAST YEAR'S CUT

Standing forest was cut this year and fires will no doubt soon follow. Elk County, Pennsylvania. — *Photographed by Dr. Hugh P. Baker.*



RED PINE, FOREST-GROWN

Standing on Normal School grounds, Marquette, Michigan.

done by planting seeds where the trees are to stand in the forest, or in growing young trees in nurseries and transplanting them where they are to grow to maturity—the latter, except in the case of nut-bearing trees, being by far the best system. Extensive tree-planting in some form is an absolute necessity for the future welfare of this country.

While tree-growing is the prominent feature of this volume, it is deemed advisable to give, in addition, a general view of the condition of our remaining forests, their possibilities and limits, the best method to be pursued in caring for them, and other matters that are necessary for a full understanding, by the plain people, of the fundamentals which underlie the successful growing of trees for economic purposes. Such knowledge is necessary intelligently to determine what is best to do under varying circumstances and conditions. A general knowledge of how forests are grown and cared for; the natural range and local habitat of the several important timber trees of our country; what treatment each species should receive; the character and uses of the wood of each; the difficulties surely to be encountered; and the peculiarity and characteristics of tree-life and tree-growth should be understood, in order to arrive at an intelligent conclusion as to what and where to plant. If the author has so shown all this that it will be readily understood, and if what is herein set forth will stimulate an effort to grow trees and thus aid in saving our country from irreparable disaster, then his aim will be fully accomplished.

II

PRESENT CONDITION OF THE FORESTS

No proof should be demanded to show that the products of the forests are absolutely essential to modern civilization. Neither should it be questioned that a civilized people must have such products in abundance in order to strengthen and maintain that civilization. That the supply should be ample in quantity and acceptable in quality and character is undeniable; and, furthermore, it needs little proof to demonstrate that the presence of forests assures an equable flow of springs and streams, and that in the absence of that equable flow there are destructive floods followed by dry stream-beds and disastrous erosion of the soil. Argument to show all this would be superfluous; but there are other features of the forest problem which are not so apparent or so well understood.

In former times the lumberman took only that which would make merchantable sawed lumber, and small stuff was allowed to grow; but now, between the lumberman, the tie, pole, pulp, and acid man, practically everything is taken and the ground is cleared of all timber growth that can ever amount to anything. No seed trees are left, and if fire follows, as it usually does, the ground becomes a barren waste. Land once denuded of trees and other vegetable growth is subject to inevitable erosion of the soil, and such erosion destroys not only the hillside and mountain slopes on which it occurs, but fills the water courses, and in time, through the deposition of earth brought from above by the water, may ruin the valleys also. Serious erosion renders natural reforestation impossible and makes any other very difficult and expensive, and in many cases entirely prevents it; and if such erosion is long continued it leaves the re-

gion no better than Palestine and parts of southern Europe now are.

It is believed by many that when our own forests are exhausted we can go to other countries for our supply of forest products. That will not be possible. Our neighbor, Canada, must retain enough for her own use, and she is bound to give the mother country what surplus she may have, for Great Britain is practically destitute of productive forests, although at this writing she proposes to plant, at great expense, no less than 9,000,000 acres in the United Kingdom; and much of the expense will be for the purchase of agricultural lands for forestry purposes. Already have several of the Canadian provinces prohibited the exportation of pulp-wood cut on crown lands. Of all European countries only Russia and Norway have more forests than they need, but the area of forests in the latter country is small. Germany imports one third of the amount of wood consumed within her borders, notwithstanding that twenty-five per cent of her area is covered with productive forests. France has eighteen per cent of her domain in forest, but this produces only one third of what her people consume. Except those noted none are growing enough forest products to supply their own wants, and civilized nations should recognize the fact that we are facing a world-wide timber famine, and the calamity of such a famine will come all too soon unless active measures shall be adopted to avert it; and, what is more, the erosion of the soil — in part consequent upon the denudation of the forests and in part caused by our present careless and unwise system of cultivation — when combined with the rapid exhaustion of all our natural resources, most prominent among which are the forests, will, if continued, render this globe ill-fitted for civilized human abode. The condition of our own country is fairly typical of that of the whole civilized world. It is discouraging to realize that this country of ours will, ere long, reach the high-water mark of its prosperity, but that time will soon come unless the impending

disaster of a timber famine can be forestalled. Our downward course will begin when our forests fail to supply our needs.

But supposing it were possible for us to obtain a supply of wood products from abroad, can we afford to put the destinies of this country into the hands of other nations simply because we are loath to do our duty to ourselves and those who are to come after us? A nation without forests of its own is, undeniably, a weak nation, and one that will be at the mercy of those possessing them. When the world's supply of coal is gone—and it is estimated that at the present rate of consumption two hundred years will bring about the practical exhaustion of all known deposits—those nations possessing a full and continuous supply of forest products will be the independent nations of the world. Neither should we flatter ourselves that, in the event of a failure or serious shortage of supply, some substitute for forest products will be found to any considerable extent. The enormous quantities required and the various uses wood is put to preclude the possibility of that. It is wood that we need and wood we must have or the index hand on the dial of progress of this nation will go backward never again to return.

Recent governmental publications¹ show the amount, character, and cost of most of the forest products of the United States for the year 1909. The accompanying table gives the product of 48,112 sawmills for that year. This is instructive, as it names the species of trees and the amount and percentage of lumber cut from each. It will be seen that the thirty-one species named yielded 99.9 per cent of the whole, while, as will be noted, "all others" were embraced in the remaining one tenth of one per cent. The first five furnished 73.1 per cent, the first seven supplied 80.4, and the first ten gave 86.9, while all the several species of pine

¹ *Forest Products*, Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9: Bureau of the Census, compiled in coöperation with the Department of Agriculture: Forest Service. Henry S. Graves, Forester. Issued April 11, 1911.

LUMBER, 1909

Quantity of lumber cut, and per cent of distribution, by kinds of wood, 1909

KIND OF WOOD.	Rank in pro- duction.	Quantity (M Feet B. M.).	Per cent distri- bution of total cut.
Total	—	44,509,761	100.0
Yellow pine	1	16,277,185	36.6
Douglas fir	2	4,856,378	10.9
Oak	3	4,414,457	9.9
White pine	4	3,900,034	8.8
Hemlock	5	3,051,399	6.9
Spruce	6	1,748,547	3.9
Western pine	7	1,499,985	3.4
Maple	8	1,106,604	2.5
Cypress	9	955,635	2.1
Yellow poplar	10	858,500	1.9
Red gum	11	706,945	1.6
Chestnut	12	663,891	1.5
Redwood	13	521,630	1.2
Beech	14	511,244	1.1
Birch	15	452,370	1.0
Basswood	16	399,151	0.9
Elm	17	347,456	0.8
Cedar	18	346,008	0.8
Hickory	19	333,929	0.8
Ash	20	291,209	0.7
Cottonwood	21	265,600	0.6
Larch	22	264,022	0.6
Tamarack	23	157,192	0.4
Balsam fir	24	108,702	0.2
Sugar pine	25	97,191	0.2
Tupelo	26	96,676	0.2
White fir	27	89,318	0.2
Sycamore	28	56,511	0.1
Walnut	29	46,108	0.1
Cherry	30	24,594	0.1
Lodgepole pine	31	23,733	0.1
All other	—	37,557	0.1

yielded 50.2 per cent. This clearly indicates the species of trees which produce the kind of lumber in greatest demand; a feature which should not be overlooked when determining what to plant. Although hemlock yielded 6.9 per cent of the whole, that species of tree will be practically exhausted within the next fifteen or twenty years or sooner.

In addition to this table there is here given a synopsis of other tables¹ showing the several products, their amount and cost. From this can be seen the large demand that is made upon our forests, and the enormous sum of money there is involved in exploiting them. This synopsis includes only such wood as is used for the purposes named. No account is taken of wood used for fuel, or for round timbers used in mines, or for piles and other like purposes, nor for any of the other numerous uses to which wood not sawed is put. How much of all this there was used is not known, but there must have been a large amount.²

The use of species heretofore deemed of little value has been seized upon by those who scout the idea of a timber famine, as showing that there is still timber for all purposes and some to spare, when, in fact, this new supply is

¹ *Synopsis of "Forest Products" Reports, showing purposes, amount, and cost of the wood used in the industries named*

No. of Report	Industry and Amount	Cost
1	Pulp-wood, 4,001,607 cords	\$34,477,540
2	Sawed lumber, 44,509,761,000 board feet .	684,479,859
2	Shingles, 14,907,371 thousand	30,262,462
2	Lath, 3,703,195 thousand	9,963,439
3	Slack cooperage, board feet not given .	20,195,125
4	Tanbark, 1,022,435 tons	9,968,710
5	Veneers, 435,981,000 feet, log scale . .	8,977,516
6	Tight cooperage, board feet not given .	3,716,296
7	Distillation, 1,140,847 cords	3,818,282
8	Cross-ties, 123,751,000	60,320,700
9	Poles, 3,738,740	7,073,826
	Total	\$873,253,755

² Bureau of the Census, *Report No. 10*, Department of Labor, 1908, shows that the wood used around the farm alone, such as poles, posts, rails, and the like, when added to the wood used for fuel throughout the country,—two thirds of the people use wood for fuel,—is equivalent in value to thirty-one per cent of the total value of the forest product.

only a temporary relief and would not be used were not the better species nearing exhaustion. Like the others these less valuable species will, in due time, be exhausted—and that day is not far distant—and what then? Because we can and do use inferior woods shall we conclude that these, too, cannot be exhausted? It is fortunate that we can use them, and we should take advantage of that use while they last, and grow better ones in their stead. In whatever direction we turn we shall see that the future of our timber supply is, at best, precarious, and that only by growing new forests can we save posterity from our greed and negligence.

Probably our forests are in no worse condition to-day than were those of Germany and France two hundred years ago, when those nations began reforestation. Success crowned their efforts and should ours, if we put forth the same endeavors. It is true that our civilization demands more wood per capita than has ever before been consumed by any other people; but that shows the need of greater effort. However desperate our case may appear to be, there is one thing to encourage us: European forests have been restored and made productive, and so may ours be, especially as we are blessed with more valuable species than they possess.

.

III

RESTORATION AND TREATMENT OF FORESTS

THERE are now to be found practically two classes of forests in the United States. One of these is known as "Virgin Forest," — the poet's "forest primeval," — where the full stand of trees planted by Nature still exists, and would, if not interfered with, be by her constantly maintained. The other is composed of such growth as may have been left by the lumberman after he has taken all he desired, — and with no thought of reproduction, — together with that which has been allowed to grow since the removal of the more valuable portion. This class is called "Second-Growth Forest." The areas covered by the latter class are sometimes spoken of as "Cut-over," or "Stripped" lands. When considering the increase of productive forests there can very properly be placed with this class such non-agricultural areas as were once covered with forests, but which have been repeatedly burned over and all valuable species of trees destroyed, and which are now practically barren wastes, containing little or no tree-growth that can ever become valuable. If left to the slow processes of unaided Nature they will not be reforested with valuable species in a thousand years, if ever. The area of virgin forests is far less than that of the other and it is being constantly and rapidly reduced; and from these virgin forests must our main supply of forest products be drawn until others are grown. Through judicious and conservative management, as elsewhere indicated, the capacity of our virgin forests may be increased to some extent, but the claim that it can be increased threefold (see page 4), no careful student of forest problems will concede. Looking at the problem of a future supply from any standpoint



VIRGIN FOREST OF WHITE PINE, CLEARFIELD COUNTY,
PENNSYLVANIA

we may choose, we are confronted with the absolute need of increasing the productiveness of our virgin forests by conservative treatment, and the equal need of making the second-growth areas productive by caring for such valuable species as now exist there, and also by planting where none are to be found; and this brings us to a consideration of the treatment of all forests.

Action along either of these lines — increasing the productiveness of present forest area and enlarging that area over regions where trees once grew but have been destroyed — may, in general terms, be called Practical Forestry, a science quite new to this country and but little understood by the greater proportion of our people. Still, there is nothing abstruse in it, nothing difficult to understand.

But if we cannot increase the productiveness of our virgin forests threefold, what can be done along that line? This cannot be definitely answered, owing to varying forest conditions, but some increase can be brought about, though the limit will necessarily soon be reached. In tree-life, as in all other, there is an age reached which we call maturity. When a tree arrives at that period its best economic development is secured. Thenceforth there is a decline until death wipes it out of existence. When trees are mature they should be removed and give room for others to grow in their places. All the time embraced in the life of a tree from maturity until it falls to the ground is just that much time lost in the use of the land which it occupies. Removing such mature trees as are not required to produce seed for a future growth is known as Selective Cutting — sometimes called Conservative Cutting.

If there should be found immature trees of valuable species interfering with each other, the weakest should be removed, as should also all diseased ones of any kind. If badly developed trees or those of worthless species occupy any portion of the ground, these, too, should be cleared away, unless they will, for a time, serve as “nurse trees” to compel the valuable ones to grow tall and free of limbs.

Such work is termed Improvement Cutting. Thus by selective and improvement cutting man can prevent the waste of time Nature indulges in and thereby increase the productiveness of the forest. That is about all that can be done along this line with virgin forests, but it should be rigidly carried out if conditions do not indicate that the whole stand should be removed and a new forest planted, a point which will be discussed later on. But no treatment of virgin forests can be depended upon to increase materially the area of productive forests, and that is what is absolutely necessary in this country.

All will agree that land suitable for agriculture should be reserved for that purpose; but it is equally true that land not so suited, and which has once borne a crop of trees, can and should once more be devoted to that use; and there is a large area of that kind of land in this country. Reclotting such land with trees is called Reforestation. It embraces replacing trees that have been removed from a forest for any cause; and, likewise, contemplates sowing seed or planting young trees in a forest, whether virgin or second-growth, where too few exist for profit: or where those standing are of undesirable species; and it also includes a complete restoration of tree-growth by sowing or planting seeds or trees on any barren land where trees once grew, or can be made to grow. When dependence is placed on Nature to sow the seed for renewal the system is known as Natural Reforestation; and when man aids by removing a portion of the trees, so that Nature may sow seed where it will have a chance to grow, or he himself sows the seed or plants the trees, the scheme is very properly called Artificial Reforestation.

It will thus be seen that there are substantially two methods of reforestation; one by natural processes alone, and the other largely, or entirely, through the instrumentality of man. The former is the one by which Nature brought forth the virgin forests and by which she would perpetuate them if allowed to do so. She grows and ripens

the seeds and provides means for their distribution. To the seeds of most trees she gives wings, that they may travel on the winds and find a home far away from the parent tree; while she leaves the task of scattering some to the birds, squirrels, and other animals, and trusts to varying chance and opportunity their subsequent life and growth.

NATURAL REFORESTATION

To understand fully the results which are likely to ensue from natural reforestation it will be well to study the history of an average forest. Naturally, as stated, trees spring from seed, grow, reach maturity, become old, die, decay, and Nature arranges for others to take their places. If the seeds are ready to fall in the place of fallen trees, or otherwise unoccupied ground, and conditions are such that the seeds will germinate, and the surroundings are such that the young trees can triumph in their struggle with other growths of the soil, or sprouts come from those that are growing old, then natural and profitable reforestation will take place in good time; but if the seed is not ready at the right time, or the conditions are not favorable, then the seeds of worthless species may, and almost invariably will, come and occupy the ground and a valueless forest will be the result. The same thing may occur when a portion of the trees are removed by man, with the additional chance of failure through the removal of seed-bearing trees, or injury to those left standing through the removal of the others.

Besides this the valuable species of trees in a given forest may all be ripe and fit to be removed, and actual loss occur if any of them are allowed to stand longer; or they may be few in number and surrounded with worthless ones. To remove all the valuable ones in either case would preclude the possibility of natural reforestation with valuable species; and to remove the worthless ones, or a large portion of the others, might prove disastrous because of the inability of those left to endure their changed surround-

ings. In either event worthless species would be almost certain to spring up and the whole character of the forest liable to become changed. The second-growth forests of the country attest that fact. It is seldom that a cut-over forest consists of the original species. This may occur, however, where, as in some sections, such trees as Redwood, Chestnut, and some of the Oaks throw up sprouts from roots and stumps. A Chestnut forest can be depended upon to reproduce itself naturally with a good deal of certainty, but in a few generations of sprouts the root system becomes so weakened by cutting that seed-grown trees must be substituted. Moreover, sprout trees seldom attain a large size if allowed to grow. The decay which takes place in the stump affects their vitality.

There is another important feature which should be considered when deciding upon the method of perpetuating a forest; and that is its productive capacity. The appended table¹ shows the net annual revenue that is derived from nearly all European forests, and also from those of the United States, the revenue being necessarily based upon the yield. The first eight countries named follow artificial methods of reproduction to a greater or less degree. The first four — Württemberg, Saxony, Baden, and Hesse — carry it on intensively, while the remainder of the list shows the relative care, or, rather, lack of care, given to their forests by man, our own country showing a deplorable negligence. From this it will be seen that natural regeneration requires a much larger area to be devoted to tree-growing than would be necessary to produce the requisite amount of lumber if artificial reproduction should be depended upon. Had we, fifty or sixty years ago, set aside as much forest area as could have been spared, and treated the whole in a conservative manner, conditions would be far different from what they are now.

¹ The annual yield of our forests is far less than those of Europe where they are maintained through artificial methods. There the average yield is forty cubic feet per acre; ours does not exceed twelve feet. Some Prussian

Furthermore, the practice of cutting the mature and leaving the immature trees must necessarily bring about a very irregular harvest. Trees left at the first cutting will quite likely be of all sizes from seedlings up to a size nearly large enough to cut, and the periods of their maturity will vary accordingly. This will compel frequent cuttings with varying yield. Therefore roads must be kept up and mills with appliances for manufacture be maintained with but small product. Such a system would do well for the farmer's woodlot, but would not be profitable as a lumbering proposition.

Finally, and by no means the least serious drawback to selective cutting and natural seed-sowing, is the probable failure of seeds to bring forth trees, even if they fall in abundance in suitable places and at the right time, all of forests yield seventy cubic feet. The following table, copied from *United States Forest Service Circular*, No. 140, entitled "What Forestry has Done," will show the net revenues received by European countries, and also the annual expenditures:—

Expenditures and revenues of national forests, showing higher productiveness under larger expenditures ¹

COUNTRY	Total net revenue from Govern- ment forests.	Expenditure per acre	Net revenue per acre
Württemberg	\$3,098,428	\$2.05	\$6.60
Saxony	2,299,000	3.00	5.30
Baden	829,162	3.58	4.42
Hesse	744,209	1.25	4.29
Switzerland	237,663	1.32	2.55
Prussia	17,054,144	1.58	2.50
Bavaria	5,128,348	1.99	2.22
France	4,737,250	.95	1.75
Italy	—	—	.33
Hungary	—	.34	.32
Austria	5,313,000	.56	.21
Roumania	482,600	—	.18
Spain	—	—	.17
Sweden	1,677,672	.02	.09
Russia	21,500,000	.01	.032
United States	1905-6 12,000	.007	² .0001
	1906-7 128,659	.0093	.00086

¹ Prepared from the latest available data.

² Deficit.

which is very uncertain. If they fall in the deep shadow of the remaining trees, or among bushes, weeds, brush, or other stuff, they are deposited where germination is very uncertain and infant tree life nearly impossible. At best they may fall on a forest floor the top of which is composed of leaves in only a partial state of decay. If enough moisture is found there to induce germination there is no mineral soil close by for the tender rootlet to enter and secure moisture and food, and a few days of dry weather will kill the little plants outright. Unless mineral soil can be reached soon after the seed bursts into life, or the seed-bed be kept continually moist, the life of the plant is very uncertain. With nearly all of our timber trees mineral soil is necessary to support life in infancy as well as later on. A careful examination of the area underneath the crown of a seed-bearing tree, even in a comparatively open forest, will show how few seeds bring forth plants. If the weak root is compelled to work its way down through the partially decomposed leaves to mineral soil, or the miniature stem compelled to encounter undecayed leaves in its efforts to grow upward, the chances are more than a hundred to one that failure will result. Millions of seeds may fall and not one produce a tree. From all this it will be seen that there are great uncertainties connected with natural reforestation, and wisdom demands that these uncertainties be recognized and guarded against.

It is true that natural reforestation is Nature's method, and it is cheerfully admitted that in some cases it is the best way, and when it is it should be followed; and it will be seen that it is recommended in many cases when discussing the best methods of propagating certain species; but unless the conditions and the character of trees and surroundings are exceptional, it will be found far more likely to fail than otherwise. If adopted, care must be taken that succeeding crops do not "grow smaller by degrees and beautifully less."

Accepting, then, the conclusion that we cannot, to any

great extent, depend upon natural processes for such restoration of our forests as will enable them to produce an adequate supply of forest products, we must turn to some other method whereby we can in some way aid Nature ; and when we accept that fact and act upon it we shall engage in practical forestry with reasonable hope of success. We well know that our forest conditions are quite unlike those in European countries, but ours are practically the same as were theirs two hundred years ago. Since success has crowned their efforts, why may not the same results occur here? It needs no argument to show that the principles which underlie tree-culture are alike everywhere ; therefore we should by no means conclude that we are in the dark. We have before us the results of two centuries of European experience and we certainly should profit by that experience wherever it is applicable to our conditions and climate.

We are at the "parting of the ways." One road — and it is the one we have been following — will lead us to the same estate that prevails in western Asia and much of northern Africa and southern Europe — a condition of dreary desert. If the other is followed, the shorn and treeless hills and mountains of our country may again be covered with forests, the beauty of the landscape be restored, our springs and streams once more be flowing in their former uniform fullness, and our economic needs of forest products be amply supplied. There is no middle road to take and reach success. Our forests are too near exhaustion to depend upon natural reforestation. Either they will go the way of all neglected forests, leaving this land ill adapted to the abode of civilized man, or restoration through man's efforts must be brought about. We are in no condition to defy the experience of others, or adopt theories not based on practical common sense. Mistakes in forestry are so long-lived that the errors of one generation are handed down to another. If ever the sins of the fathers will burden their children they will in this case, if we commit them.

IV

ARTIFICIAL REFORESTATION

BESIDES Natural Reforestation brought about by the system of Selective Cutting, already discussed, there may be named Strip Seeding, Spot Seeding, Broadcast Sowing, Planting in Hills, and Growing Trees in a Nursery and transplanting them into the forest, all of which are embraced in Artificial Reforestation. Some one of these methods is adapted to every locality, but all may not be to any one.

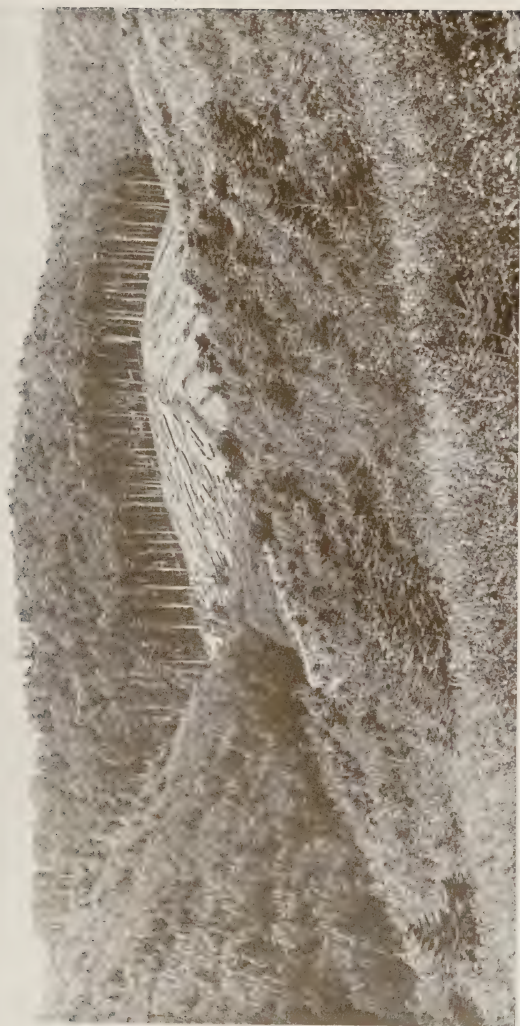
Strip Seeding. In carrying out this plan the entire stand of trees is cut from a narrow strip at the side of a forest which is old enough to bear an abundant crop of seed, choosing that side which is opposite to the prevailing winds. This operation is termed "clean cutting." The expectation is that by thus locating the ground to be seeded, Nature, through the agency of the winds, will sow the seeds. This may or may not occur, however, as there may be little or no wind when the seeds are ripe and falling, or it may blow in the wrong direction. But if seeding does occur it will not be uniform, for some seeds will be carried farther than others. Much will depend upon the velocity of the wind. At best, it will be uneven, as more seed will fall next to the parent trees than elsewhere. Consequently, in order to secure an even stand, whereby the land will be made to produce the greatest yield possible, there will be more or less work to be done in thinning in places where the young trees are too numerous and planting where there are too few.

If no seeding occurs the year the trees are cut, delay must ensue until another seed year comes around, which, with conifers, may not occur for several years, — on an av-

erage not oftener than once in five years, — thus delaying reforestation. Of course it will be seen that this system is suitable for only such species of trees as have winged seeds. The width of the strip cut should not exceed twice the height of the trees unless the ground slopes rapidly away from those left standing, as in that case the seeds would be carried farther than if on the level or uphill. Examination should be made of the trees to be left standing to ascertain if they will furnish seed the year that it is proposed to cut the timber. If it is not evident that seed will be forthcoming at the right time, delay in cutting must take place, for if cutting is not followed the same year by seeding, failure will be very apt to result through a growth of sprouts, shrubs, weeds, or from some worthless species of trees springing up, and these may be so far advanced when seeding does occur that germination cannot take place, or, if it does, the young trees will be suppressed. To insure germination the surface of the strip is sometimes gone over with some implement that will scarify it and expose the mineral soil for the seeds to fall into. However satisfactory this system may prove in certain cases, it is not practiced to any great extent in European countries. In Saxony, where are the most perpetually productive forests in the world, in an average annual reforestation of sixty-nine hundred acres only eight hundred are from seed sown by this method. Yet there is no question but that it may serve a good purpose in some situations, and especially so with such conifers as are frequent and prolific seeders. On rough, rocky, or swampy ground where planting young trees would be difficult this system may prove the best of any. Of course it is obvious that in all cases where natural scattering of seeds is to be depended upon, the species of trees to be grown must be that of the stand from which they come, and if the parent forest is of mixed species much must depend upon whether all will bear seed in the same year, and, if so, whether all will be scattered alike. In short, there can be no satisfactory control of species likely to occur. In this

respect it is no better than, if as good as, that which may result from selective cutting, for, under that system, undesirable species may be removed before seed-sowing.

Spot Seeding. Still another method of aiding Nature in sowing seeds prevails to a certain extent in Europe and is known as "**Spot Seeding.**" In principle it is substantially the same as Strip Seeding. Observing when the forest trees will mature seed, a spot, circular or otherwise, is chosen in the forest and cut clean of trees. Then as the seeds mature the wind is depended upon to sow them on the vacant area. This has one advantage over the strip method. No matter from which direction the winds may blow at the time the seeds fall, the ground is almost sure to be seeded, for it will be entirely surrounded with seed trees. But whether this or the Strip method is adopted there is almost certain to be an irregular and unsatisfactory distribution and scattering of the seeds, — too many in some places and too few in others, — and there must be a thinning in some localities and planting in others; and, furthermore, no satisfactory control of species can be obtained, nor can seeds from nut-bearing trees be sown by the wind. Besides this, the system leaves the forest in an irregular stand, with mature and immature trees in clumps and more or less interfering with roads and fire-lanes. Another objection to it is that the mature trees left may have to stand a long time before they can be cut, for when they are removed no seeding can occur on the ground occupied by them until the adjacent younger ones bear seed, which, with most conifers, does not occur under thirty or forty years from birth. In this feature it is not as satisfactory as Strip Seeding, for then there is taken a strip, from time to time, until the whole is gone over; and by the time the last strip has been cut the first one sown may be mature, and the process can be repeated. The features which make it superior to that method are greater certainty of seeding and protection of young trees from wind.



CHARACTERISTIC VIEW IN THE WIENER-WALD

Norway Spruce culture in the foreground, to the left young stand of Beech with scattered Spruce and Fir. Clear-cut area in the middle with the timber ready for removal and mixed woods of Beech and Silver Fir in background. Austria. — *Courtesy of U. S. Forest Service.*

But notwithstanding the objections named, Spot Seeding may, in some places, do as well as Strip Seeding. Especially so may it serve a good purpose with the Spruces and the Southern Pines, and also with the Western Hemlock and Douglas Spruce of the Pacific Coast. But in all cases injury is likely to occur to the young trees in felling and removing the mature ones.

Thus far, in the schemes considered for reproducing forest trees, dependence has been placed entirely upon Nature's production and reckless distribution of seeds, where she gives thousands and thousands for every tree that matures. In Strip and Spot Seeding man aids much in removing the danger of suppression of young growth by overshadowing trees or in their being robbed of food and moisture, as none are left to do that, while the surface is left in much better condition for the germination of the seeds because of the more or less disturbance it undergoes in removing the stand, and the consequent exposure of the mineral soil. However satisfactory one or both of these schemes may at times prove to be, there is now but a limited area of forests in this country where either of them can be successfully applied. Each requires a fairly full stand of mature trees to produce seed and in but few situations are there enough such left to justify any dependence being placed upon them. Only with dense forests of valuable species can they succeed. They may aid, but some one or all of the other systems must be largely adopted if our country is to be supplied with the greatly needed forest products. Nature must be aided in forestry as well as in agriculture. Seeds must be gathered and sown in some fashion and the greatest care should be exercised in selecting the best species and adopting the best methods of growing trees from them.

That better methods than any yet named can be chosen there is no question, and these will now be discussed. They are known as Broadcast Sowing, Planting Seeds in Hills,

Growing Young Trees in Nurseries, and, when at proper age, transplanting them into the forests. Of course, all these presume the gathering of seeds, a subject which will be discussed when the various species of timber trees to be grown are described.

Broadcast Sowing. This is nothing more or less than scattering by hand a suitable amount of seed as evenly as possible over barren or partially covered ground, just as a farmer sows his grain without the aid of a drill or other seed-sower. To be at all successful the ground should be cleared of trees, brush, and weeds, for if these are present in any considerable quantity the young trees will be suppressed by them should the seed germinate. If it is gone over with any implement like a harrow, which will scarify the surface and expose the mineral soil, there will be much greater certainty of satisfactory results. A light brush harrow, dragged over the ground by hand after the seeds are sown, will so cover them as to cause quite a satisfactory germination. In the absence of such treatment of the surface the seed should be sown on a light snow in the spring, and when the snow melts, the seed will be more or less carried down by the water into the soil, if it is exposed, or among the leaves and litter if such are present.

There are several somewhat serious objections to this method. One is that germination of the seed is very uncertain. It may not fall in a suitable place or may not be covered. To overcome this a large amount of seed must be sown. In Schlich's *Manual* it is claimed that six pounds of White Pine seed should be sown on an acre of ground. A pound of that seed should produce, in a nursery, from fifteen thousand to sixteen thousand young trees, enough to plant between eight and nine acres of forest; and if the seed costs only two dollars per pound — a low figure — the expense would be as great, if not greater, than to plant trees from the nursery. Again, it is utterly impossible to secure an even stand by this method. Many places will require thinning, while others will have to be filled in. Be-

sides, birds, mice, or squirrels may, and in many cases will, consume much if not all the seed. When all things are taken into consideration it is neither as economical nor in any way as satisfactory as planting in hills or raising trees in a nursery and setting them out. It has one redeeming feature,—the species can be selected.

Planting in Hills. This is simply planting a few seeds in places where the trees are to stand in the forest, substantially as a hill of corn is planted. The ground can be spaced off in some convenient and cheap way, so that the hills will be equidistant and the proper number placed on the ground. With a hoe or other implement the ground can be slightly loosened on the surface and the requisite number of seeds dropped in and a very light covering of soil drawn over them, unless nuts are planted. Three sixteenths of an inch is deep enough for most seeds with wings, but nuts should be planted from one to two and one half inches deep. If the ground is stony or rough, or obstructions of any kind prevent regular spacing, the hills can be put in where conditions permit, for exact spacing is not essential. This system is well adapted to stony, rocky, or rough ground where it may be difficult to find suitable soil into which to transplant young trees. Furthermore, if the ground is that of a dry ridge or steep hillside, or any other place where the water soon disappears after a rain, seeds may germinate and trees grow, just as they do in natural seeding, when, if a tree were planted into such soil, there might not be enough moisture to give it strength to overcome the great shock it must endure in being transplanted.

The number of seeds to be dropped in a given place must be governed by the ascertained percentage of germination. Ordinarily fifty per cent of coniferous seeds may be expected to grow in the nursery, but it will be well to put in not less than six—somewhat separated from each other—when planting for a forest, and when the little

trees are well established, all, except the most vigorous one, should be removed. If any vacant places should be found, they can be filled in with some of the surplus trees. Besides controlling the species this system insures an even stand, something which cannot be brought about by any other except planting trees, and in many places it will be preferable to that. It may do well if carried out immediately after a fire has killed all the growth of trees, shrubs, weeds, or grass. The greatest drawback to this method is, that if the ground is covered with weeds, grass, or bushes, these may suppress the young trees in their infancy. This objection may be overcome by clearing the ground, as for broadcast sowing, or removing for a foot or so whatever may be likely to suppress them.

As there can be no strip, spot, or broadcast sowing with the seeds of nut-bearing trees, all such must be either planted in this way or the plants grown in a nursery and transplanted into the forest—a proceeding which is not always successful. Nearly all of them have a more or less prominent tap-root and some will not submit to its loss and thrive, and planting seeds of such where the trees are to grow is much the best way, if no suppression by overshadowing growth is permitted.

Growing Young Trees in a Nursery. The last method to be considered is planting the seeds in a nursery and, when the little trees are large enough, transplanting them into the forest where they are to grow to maturity; and it is by no means the least important one. At first thought this may seem to entail an unnecessary expenditure of time and money. Experience, however, shows that there is, in the end, economy of both. There are cases, as heretofore shown, where other methods are best, but they are exceptional. Planting in hills is the only one that can be expected to approach it in satisfactory results; but if trees be grown in a nursery until they are three or four years old—the period of slowest growth of nearly all the con-

fers — and then transplanted into the forest, they are better able to cope with their adverse surroundings than if compelled to struggle for life when ill fitted to do so.

To carry out this method the seeds are sown in beds in the nursery, carefully protected from drouth and too much sunshine, cultivated and defended from the encroachment of weeds and disease, and, when large enough, transplanted into the forest. With the pines and other conifers transplanting is generally done when the trees are three or four years old, but with broadleaf trees most of them may be removed from the nursery when only one, two, or, at most, three years of age.

This method of reforestation possesses the same advantages that broadcast sowing and planting in hills enjoy by giving full control over the species composing the forest. Only suitable ones need be grown. There need be no weed trees — species worthless for lumber. An even stand can be secured and the greatest yield of forest products obtained. As more trees should be planted in the forest than can ever reach maturity, — this to compel those that may be left to grow tall and drop their lower limbs, — the defective and less thrifty ones are discarded, as hereafter described, and the resultant stand will all be perfect trees. Forestry should be carried on along the same lines that other business enterprises are, and satisfactory results should be sought and obtained. The aim should be to secure the greatest value of forest from the smallest possible area, or, in other words, to secure the greatest percentage of profit on the money invested, and perfect trees are more valuable than imperfect ones.

An acre of virgin forest may have seventy-five mature trees standing upon it — the average is far less than that — and it may be assumed that it has taken that number of years for them to grow, or an equivalent of one tree a year. It may also be assumed that as fast as any are cut others will be naturally planted in their places so that the stand will remain the same. Another acre may have two hundred

similar trees, — the average number of a planted mature forest, — all to mature in seventy-five years and all to be replanted when removed, the same as the others. The first acre will yield one tree a year and the second two and two thirds trees in that time. It will cost no more to care for one than the other, and hence the profit must be in still greater ratio than their yield. Besides this, the character of the lumber grown in sparse or uneven stands and where open spaces occur is always inferior in quality to that grown where the trees are all tall and free from limbs.

To be sure, growing trees in a nursery and transplanting them into the forests cause a greater expenditure at first, and that must be reckoned with; but calculation will readily show that this increased cost, at compound interest, is not proportionately as great as the increased value of the product. Experience in countries growing artificial forests has led to a wide adoption of this system of reproduction. Saxony is reputed to have one acre of forest nursery to every one thousand acres of forest, and in that kingdom will be found forests producing the greatest revenue. Switzerland has seven hundred and eighty acres of forest nurseries, and plants about twenty-two million trees each year.

The absolute control of the species of trees composing the forest, the uniform and excellent quality of the lumber produced, the largely increased yield, the even age and size of the trees at maturity, together with the much greater certainty of securing a full stand, are features which challenge serious consideration.

V

FOREST DEMANDS

Moisture. Moisture in the soil is as essential to tree-growth as it is to any of our farm crops. We cannot control the amount of moisture given us, but, to a great extent, we can so care for the forests that rain, and the water from melting snows, will not quickly flow off from the ground on which the trees stand, but be more or less retained and its presence in the soil of the forest extended over a much greater period of time. The claim that the presence of forests conduces to increased rainfall has never been conclusively proved. Only observations extending over a long period of time, and over a reasonably large territory once covered with forests and afterwards denuded, or the reverse, can determine that; hence no such claim will be made in this discussion. The effort will be to show what can and should be done to utilize such water as may be granted us. It is well known that when the mineral soil has no covering, much of the water falling upon it runs off rapidly, and also that evaporation of what may be absorbed by it soon takes place. Observation has likewise shown that if the soil is covered with a loose, spongy coating of vegetable matter, neither run-off nor evaporation can go on so rapidly. Neither can evaporation proceed so swiftly in the shade, or where protected from the winds, as when the surface is exposed to every breeze that sweeps over the land.

We know that trees and other vegetation must be supplied with water. Unless a supply can be furnished to the root hairs and cells there will be no sap to carry the mineral food to the leaves, and without that there can be no growth. As a rule there is a mean of water supply which must be maintained for most species to secure the best results, and

experience shows that a departure from that mean almost invariably occurs on the side of an absence of a sufficient supply, and this brings us to a consideration of an important feature connected with the growth of timber trees.

The Forest Floor. When the ground is covered with a growth of trees, the twigs, leaves, branches, and dead trees which fall and decay produce, in time, a covering of a spongy character that not only is capable of itself retaining water but prevents its rapid run-off, thus giving it time to percolate into the earth, which is always looser and more porous on account of such covering. From there it is absorbed, in part, by the roots of the trees and sent to the leaves, as elsewhere shown, and the supply of water is longer retained than when the naked mineral soil is exposed, — the greater part, however, entering the porous soil and supplying springs and streams with a gentle flow, — and thus in a large measure preventing excessive floods on the one hand and dried-up springs and stream-beds on the other. While some of the water is evaporated from the surface, that process goes on slowly where the ground is largely shielded from the sun and wind. This moisture-holding, spongy mass of decaying leaves and wood which covers the ground on which the trees grow is known as the *Forest Floor*, and its proper maintenance is of great importance. To produce and keep it satisfactorily the trees in the forest must stand close enough to shade the ground completely, and there must be enough decaying leaves and wood to provide an ample thickness.

This decaying matter forms the well-known humus, that most valuable constituent of the soil which converts the disintegrated and decomposed rocks of the earth from comparative barrenness into fertility. Mingled with the mineral earth, it forms the fertile soil. By its accumulation the ground is constantly enriched, and the forests thus pay an annual rental for the ground they occupy. In cultivated fields there is no such accumulation, and instead of a constant enrichment there is a continued drain upon its fer-

tility by the growth and removal of crops and by erosion. If the forest has been growing long enough this decaying matter will be found mixed with the earth to quite a depth, changing it from barrenness into fertility and giving to it a porous character and a darker color. Not only does it add valuable chemical constituents to the soil, but the decaying vegetable matter acts mechanically in keeping the soil loose.

The importance of maintaining a suitable forest floor cannot be too strenuously urged. When not amply provided, the trees suffer, in part through lack of a continuous supply of moisture which is secured by its presence, and in part through failure to receive the elements of fertility which the leaves may secure from the atmosphere; and the result of a failure to maintain this ground cover is always manifest in the slow growth of the trees of the forest. A typical productive forest is one where the crowns of the trees practically shut out the sunlight and where the ripened foliage, cast-off bark, and decaying wood so completely cover the ground as to prevent a rapid run-off of the water that may reach there, retaining a portion which, for a while, will supply the roots of the trees that are near the surface, and also prevent the rapid evaporation which would occur were not such covering present. The necessity for preserving the forest floor intact was experimentally learned in Europe some time ago where the freshly fallen and decaying leaves, bark, and wood were, by permission, removed from the forests by the peasants. It was discovered in due time that the forest-growth was severely interfered with through such removal, and it was prohibited. Experience proves it is necessary to secure a complete covering of the ground by the foliage as early as possible in the life of a newly planted forest in order to prevent evaporation of moisture, and to hasten the time when the cast-off leaves, bark, and twigs will furnish the greatly needed protection for the ground. This, as well as to secure a growth free from limbs, renders close planting necessary.

The Forest Crown. While the forest floor is important,

the forest crown must not be overlooked. These two features of the forest are intimately connected with each other. The condition of the crown indicates the rapidity and vigor of growth of the body of the tree from which the lumber must be cut. If the trees are so great in number as to cause the roots seriously to rob each other of food and moisture, or if the forest floor does not completely protect the root system with decaying leaves and the like, then the growth of timber will be satisfactory in neither character nor amount. If the crown is so open as to allow weeds and grass to grow, that is evidence that there are not trees enough. The shade should be so dense as to suppress whatever is not useful. If the trees are so close that there is not enough food or moisture to maintain a vigorous growth, and the tops of the trees show a diminution of annual height growth, or some trees are being suppressed, then there are too many and some should be removed. There should be an equilibrium preserved between root and crown. The condition of the forest crown should be carefully observed, for there the first indication of lack of vigor or of injury or disease will manifest itself. While the twigs and leaves may not be the most vulnerable, they are the first to give the alarm. An insufficient supply of moisture to the roots will in a short time surely show itself in the crown.

In mature age, and when the trees increase in height but slowly, — as will be the case in time, for there is a limit beyond which a tree will not grow in height, and that limit is gradually reached as it approaches maturity, — they may stand so far apart and the crown be so open that the sunshine can reach the forest floor and allow the grass to grow. If so the grass should not be fed off by stock. Even though the grass absorb moisture it does not rob the ground of food, if allowed to remain and decay, while its removal not only does that, but exposes the soil to more rapid evaporation, and even erosion. There should be shade and covering for the forest floor and sunlight for the forest crown.

Light. Light is absolutely necessary to the growth of trees. The result of closing the stomata — the breathing-pores of the leaves — which an absence of light brings about, is elsewhere shown (page 70). But all trees are not alike in the amount of light they require to maintain a fairly vigorous growth. All will do best by having a proper amount, but some demand more than others ; or, to state it in another way, some can endure more shade than others. Those which can endure the most shade are termed “tolerant,” in contradistinction to those which can endure little or none, and the latter are designated “intolerant.” The need of light which some species manifest has greater significance when natural regeneration is depended upon than when a forest is established by sowing seeds or setting out trees. In the former many trees, whether tolerant or otherwise, may be driven out because the rapidly growing ones will suppress them with their shade ; and the fact that nearly all of the most valuable timber trees are light-demanding makes this possibility a feature which should not be overlooked. Most of the Oaks, the Pines, Spruces, Hickories, Elms, Ashes, Cherry, Basswood, Yellow Poplar, Larches, Chestnut, and several others are more or less intolerant, while Sugar Maple, Beech, Hemlock, and a few others are more or less tolerant, and will thrive, after a fashion, in the shade of their own or other species. Hemlock will grow under a white pine, but a white pine will not thrive and reach a full growth in the deep shade of any tree. It can be easily determined whether a tree is intolerant of shade even when growing in the open. If the small twigs and limbs, which at first grow next to the stem and large limbs, are dead or dying, and the leaves of the tree are mainly on the outer surface of the crown, or none of moment next the large limbs, the tree may be set down as intolerant to a great degree. Some trees, as Maple and Beech, may have nearly the whole top a quite dense mass of small limbs and twigs bearing leaves, while a White Ash, Cherry, or other intolerant tree will have the interior of its crown open and the

twigs and leaves all on or near the outer ends of the limbs. All species require more light in old age than in early life.

DO FORESTS IMPOVERISH THE SOIL ?

Soil exhaustion is a very important feature when considering plant growth and should be well understood, and it is as well to know what demands are made upon the soil when we propose to grow a forest as when farm crops are to be produced. Investigations made in Bavaria show that an acre of wheat requires 27.9 pounds of potash and 22.7 pounds of phosphoric acid, while an acre of beech forest demands only 13 pounds of potash and 11.9 pounds of phosphoric acid, the wood-growth requiring about one half as much as the wheat. The difference is more marked between potatoes and pine, the former exacting 79.5 pounds of potash and 26.8 pounds of phosphoric acid per acre, while pine requires but 6.6 pounds of potash and 4.3 pounds of phosphoric acid, the potatoes calling for eleven times more potash and six times more phosphoric acid. The discrepancy is nearly as great in the demands for nitrogen, for 12 pounds per acre for broadleaf trees and 80 pounds for potatoes.¹ Conifers require less of the absolutely necessary food for tree-growth than deciduous trees.

When we take into consideration the large amount of plant food given to the soil from tree-growth, one half of which is received from the atmosphere, and the amount drawn from the soil, — and what it calls for there is mainly obtained deep down in the earth, and below where most farm crop roots reach, — it will be seen why forests do not

¹ Were it not for the constant return to the soil, of potash, phosphoric acid, and nitrogen by the forest, this annual drain, by the trees, of the elements of fertility would amount to a large sum during their growth, but by no means as great as would be the drain upon these elements by the farm crops for the same length of time, and with no compensating return whatever. Dr. B. E. Fernow, in his *Economics of Forestry* (page 451), says: "In the average there are annually returned by the fall of leaves and litter in a dense forest from 1800 to 4500 pounds per acre, according to kind and condition of growth and soil, from 22 to 220 pounds of minerals, potash, phosphoric acid, magnesia, lime, etc., and 12 to 60 pounds of nitrogen."

impoverish the soil, but actually enrich it. Every one having had experience knows that newly cleared land is more fertile and more easily worked than fields long tilled, unless the latter have been fertilized artificially. It is true that when the forest crop is harvested there is a large amount of wood removed, but no great quantity of the elements of fertility required for farm crops is taken away. The composition of wood shows that. Approximately one half of the wood is carbon, forty-two per cent oxygen, six per cent hydrogen, and only one per cent nitrogen and the same amount mineral ash. The nitrogen and what potash and phosphoric acid there may be in the mineral ash are all the important elements of fertility for the agriculturist that are taken from the land from the time the tree springs from the seed until it is harvested, — and all that time it has been giving more to the soil in its decaying leaves than it has taken, — while a crop of wheat will take twice as much in one year and return nothing. Neither do trees require as much surface moisture as farm crops. While it is true that some of the water falling on the trees never reaches the ground and is evaporated from the leaves, twigs, and limbs, there is enough falling on it to keep it moist much longer than in the open field, owing to the protection of the surface, from the sun and wind, by the foliage and forest floor.

VI

DIFFICULTIES OF REFORESTATION

It must be admitted that the reforestation of our cut-over and burned-over lands is beset with many difficulties. Few of our people have thought that we should ever be compelled to replace them by planting trees. We have given little or no attention to restoring our forests, and have allowed the very worst conditions to fasten themselves upon much of the area upon which the forests of the future must stand, and we now find ourselves confronted with difficulties which neither should nor would have occurred had proper measures been taken in time to avert them. That it will be expensive and difficult successfully to replant our cut-over and burned-over lands must not deter us from undertaking the work. Whether it will cost little or much, or whether it will be easy or difficult to bring about, cannot now be considered, for it is an absolute necessity. It is a duty which we cannot evade, for the prosperity of the nation is at stake, and wisdom dictates that we should make thorough investigation and adopt the best possible measures.

The land upon which the forests of the future must grow can be divided into four classes, but the lines of demarcation are not very distinct. One class is where all tree-growth has been destroyed by the axe and repeated fires, and where nothing but bare ground or ferns, briars, weeds, and shrubs can be found. Such land has suffered greatly from having its humus practically destroyed and, in addition, its fertility greatly lessened by erosion. In the main, such areas can be reforested with a fair chance of success if erosion has not gone too far; but the growth will be slow for a long time, consequent upon the loss of fertility. The

crop of weeds will somewhat interfere with and hinder the growth of the young trees that may be planted among them, but if fair-sized strong plants with good root development are selected, the weeds, unless very dense, will not seriously hinder. The cost of reforesting such areas will be as low as that of any, and less than some, but that will be offset by slow growth for several years. After the ground is well covered with the shade of the trees planted thereon, and a proper forest floor secured thereby, the growth will assume a natural vigor.

Another class is land on which the total destruction of tree-growth has not occurred, but where worthless species predominate to the practical exclusion of all others, and where reforestation with valuable ones cannot occur until the objectionable ones are removed. Such land was undoubtedly burned over after the lumberman had taken what he cared for, but the fires have not been so frequent or so severe as to destroy all tree-growth, and the result is that Fire Cherry, Trembling Aspen, Sumac, Scrub Oak, and other worthless stuff have sprung up and now cover more or less of the ground. In much of such territory this growth is so dense that no planting of valuable species underneath or among it should be expected to grow. It would be suppressed if planted. The seeds of these worthless species have been scattered over the land by the winds and birds, and as all are rapid growers in early life, they outstrip all valuable ones and take and keep possession of the ground. How to get rid of this encumbrance is not easily indicated, and each case should be dealt with according to its distinctive conditions; but the removal must be effected in some way before planting can be successful; and the cost may be considerable. Probably the easiest and least expensive way, but most destructive to the fertility of the soil, would be to surround the area to be planted with a fire line cut wide enough to enable those in charge of the work to prevent fire escaping, and then burn over the tract as soon in early spring as possible, and at once set out strong

healthy plants or plant seeds. There would probably be some places where the fire would not kill all, or, if killed, all would not be consumed. In that case the axe must be used and the brush be piled and burned. As there may be adjacent territory that cannot be burned at this time, there will, no doubt, again be seeds of worthless species scattered on the tract planted; but if the plants set out are vigorous and of good size, they will be able to hold their own in most cases. If not, and they are likely to be suppressed by the fast-growing intruders, then the intruders must be cut down. The farmer cannot permit weeds to choke out his crop, and no less can the forester allow it.

Another way to prepare such ground for planting is to cut and pile the objectionable tree-growth in late fall or early spring and burn it without permitting the fire to run over the ground and destroy the humus, and in the spring to set out strong vigorous plants. This will save the humus that may have accumulated, but this method is expensive and there is danger that a new growth will come from sprouts, for there will be more vigor left in the roots than if the fire had done the work, and there will probably be some seeds remaining there which have failed to germinate for want of opportunity or time, and these will send up a new crop of pests. If the worthless stuff is sparse, quite likely cutting and burning will be the best plan. Conditions must determine which plan to adopt.

There is another class of land from which, unfortunately, little can be expected at present, for those who have to do with it have not yet learned that we are in the beginning of a timber famine, or that the best time to reforest is immediately after the removal of the virgin stand, or even that there is any necessity for reforestation. It is where forests are being removed and where, if not promptly reforested with valuable species, there will come a mixed growth of useless and valuable species, but over which the useless ones will, in time, assert and maintain supremacy and prevent satisfactory results. If planting on such terri-



A VIEW IN THE FOREST OF PRINCE BISMARCK,
FRIEDRICHSRÜHE, GERMANY

Compartment line serves as fire line and road. Spruce, planted.
Courtesy of Professor Filibert Roth.



AN OLD PLANTATION OF SPRUCE NEAR EISENACH

Star-shaped rows. — *Courtesy of Professor Filibert Roth.*

tory is to follow removal of the forest it should be done at once, and before the seeds of worthless species can be sown. Cut the forest-growth clean, pile and burn the brush, but prevent fire from running over the tract, and either plant seeds or set out trees in early spring next after removal of the forest. If a year is allowed to elapse, a growth of stuff will spring up and the planted seeds or trees will have an unnecessary battle to fight, which may end in their defeat. If no planting is done, and fire does not run over the ground, a growth of weed trees mingled with good species will come up, and the weed trees, being faster growers than the others, will suppress the useful ones, as elsewhere under like conditions, the same as on burned-over ground. Only prompt planting can bring success. This method is largely followed in Europe where intensive forestry is profitably carried on.

There remains to be considered one other condition of the ground where planting trees is certainly advisable. That is in abandoned fields where there are few or no obstacles in the shape of tree-growth, and where grass and low weeds cover the ground. If there is a sod on the ground experience shows that the young trees will usually do better when planted in it than when it has been ploughed under, unless a year or more elapses before planting, for if planted on newly turned sod the plants are liable to die through drainage of the moisture from the roots into the open spaces surrounding the sods. Moreover, the vegetable mould of the sod, and the growth it supports, act as a cover to the soil and prevent rapid evaporation. Neither is it necessary to cut away or remove the grass and low weeds. Experience of the Pennsylvania Forestry Department has shown that young White Pines grow as well when the grass is not removed. It may, and doubtless is, advisable to plough ground and let the sod of the prairies rot before attempting to plant, and in such cases it will be advisable to cultivate the ground a few years after planting, and if the land is fertile low-growing crops may be grown with the trees for one or two years.

The varying conditions which prevail on the cut-over lands of the country make it impossible to point out what is the best course to pursue without a careful examination of each case. The location, character of soil, species of trees to plant, and climatic conditions must be considered in each case ; and therefore only a general indication of the best method to pursue can be given. There is one rule, however, applicable to all cases : the planted trees must not be suppressed by worthless species, and every advantage possible should be given them.

VII

PLANTING THE FOREST

SHOULD THE SPECIES BE MINGLED?

IF the necessity for planting forests to restore them where they have been destroyed be admitted, — and it cannot be truthfully denied where productive forests no longer exist, — the method to be adopted becomes an important matter, and we naturally turn to see what Nature did when she grew them so abundantly. In the virgin forests of our country several species of trees demanding like conditions of climate, soil, and situation are found growing in close and intimate association. Broadleaf trees lock their limbs in apparently friendly embrace while they tolerate the conifers and are by them welcomed. But for all the apparent harmony and good-fellowship, there is a silent but persistent struggle going on both in the air and under the ground for supremacy and even existence. All must have light, — some species more than others, — and nearly all more in old age than in youth. This strife never ceases and it ends in a vast number of fatalities. So, too, all must have mineral food and moisture, and the battle in the ground between the roots is more stubbornly contested than is that in the air between the leaves. In both cases a tree will contend with one of its own species or with that of another, and class will war with class.

Neither does the conflict show any sympathetic spirit, nor are there any rules of warfare recognized, and the result is simply a survival of the strongest. When mature trees fully dominate the ground they practically suppress all young growth underneath their branches, and not until they fail from some cause can a new forest be grown. They give no opportunity for other trees to grow and rob them of light,

food, and moisture. And this struggle causes them to assume a different shape and form when growing in close proximity to unwelcome neighbors from that taken when not so crowded. In the effort to overtop their companions and obtain the needed light, they grow tall, their lower limbs die and drop off, and the result is that such trees become valuable for lumber — much more so than if grown in the open — and this warfare inures to the benefit of mankind. We have thus far reaped the fruits of a conflict which has been constantly kept up in our virgin forests, and it will most certainly be to our advantage so to plant in the future that the contest for supremacy will be continued. Naturally conditions of soil, climate, and location have caused certain species to segregate and grow by themselves, or with others whose needs are similar. In some regions none but broadleaf trees can be found, in others those with needle-like leaves, — the conifers mainly, — while in others they are intermingled.

It was seldom, except west of the Mississippi River, that the battle was fought to a finish, so that one species alone enjoyed any considerable area of ground, but where it has been the name of “Pure Stand” is applied, and where the forest is of mingled species it is known as a “Mixed Stand.” The latter is the rule and the former the exception, and when we contemplate planting a forest we must determine which of the two systems we will adopt. In other words, we must decide whether we will mix conifers with broadleaf trees, or one species of conifers with another, or mingle broadleaf trees with each other, or those demanding light with those that are capable of enduring more or less shade, — for it is only in the struggle for light that we can control, — or, on the other hand, whether we will keep separate or make close neighbors of light-demanding and shade-enduring trees. If we mingle them at all we must decide to what extent and what species we will make close companions and associates, even though it be against their wishes. All this must be taken into account when we plant the for-

est; and in considering it we must not forget that we must so plant that each tree will be crowded and forced to grow into valuable lumber; and this involves the mingling or segregation of species, — as the case may be, — the distance apart the trees should be planted, whether alone or mixed, and also such subsequent treatment as will cause them to continue the struggle and yet make the most rapid growth possible.

Unfortunately professional foresters are by no means agreed upon the best course to pursue. The claim put forth by those who advocate mingling the species, and planting tolerant¹ with intolerant ones, is based upon the fact that Nature mingles them in virgin forests, and that when a forest is destroyed by the axe of the lumberman or in any other way, she makes no discrimination either in species or toleration, but again plants them haphazard. It is also insisted that there may be a greater yield in a mixed forest of tolerant and intolerant trees than in a forest of one sort alone, because the tolerant ones can and do grow in the shade of the intolerants, and thus the ground can be made to produce a greater yield; and there is no doubt but that in naturally planted forests this is true. Beyond this it is argued that by mingling tolerant and intolerant trees a better shading of the ground can be brought about because the open crowns of the intolerant ones do not always afford a complete protection to the forest floor; and, finally, that a mixed forest is not so liable to be destroyed by insects or disease, or injured by winds, as where only one species is present.

Those who oppose mixing conifers with broadleaf trees, or planting tolerant with intolerant ones of either class, insist that the mingling of all in our virgin forests is a matter of accident instead of law or design; that Nature has made ample provisions for sowing seeds of all kinds of trees through the agency of the winds or animals, and that

¹ As noted on page 35, a tolerant tree is one which can endure more or less shade and an intolerant one such as exacts the fullest light; that is, one is shade-enduring and the other light-demanding.

seed distribution is carried on through what may truthfully be called accident or chance ; and that the species themselves have no hand in it and cannot select their companions, and that seed must grow, if at all, where it falls ; hence that what may be seen in virgin forests should not necessarily be taken as a guide.

It is further insisted by the opponents of mixed forests that experience with artificial ones abroad has shown that pure stands, or stands composed of trees of equal demand for light, mineral food, and moisture, produce the greatest yield, admitting, however, the greater liability of damage by disease, insects, or winds to a pure stand. With these and lesser arguments has the controversy been carried on and it is still unsettled, and probably will not be determined very soon ; not until experience establishes what is best in this country with our varying conditions of soil, climate, species, and surroundings ; but in the mean time we should be guided as far as possible by what a study of our forests may reveal as indicating the system of planting most likely to lead to success. As stated, we know that in some cases Nature grows pure stands and in others she mingles the species to a greater or less extent, and successfully so in both cases ; and to assume that only one of these is in all cases the true one would manifestly be absurd. Hence we may choose as conditions and necessities may dictate ; but in making a choice we should not ignore the known laws of tree-growth. Elsewhere (page 35) has been shown the demand for light which all trees make. From what is there set forth it is manifest that if a rapidly growing tree is planted in close proximity to a slow-growing one the former will suppress its neighbor to a greater or less degree. This is compensated, in part, by some trees enduring more shade than others, but that fact does not prove that those requiring less light than the others will grow better under the shade of more intolerant ones than if given full light. It only shows that the tolerant tree is accommodating itself to adverse conditions. Neither does it show that the more

rapidly growing tree is benefited by the close companionship of a slow-growing one. Therefore we may safely assume that for trees demanding like soil, climatic conditions, and situations, rapidity of growth must, in the main, be the governing factor in determining whether or not to mingle species, although the demand for moisture — broadleaf trees, when in full leaf, requiring more than needle-leaf ones — and the protection of the forest floor should not be lost sight of. There is no known law of tree-growth violated in planting either pure or mixed stands if rapidity of growth of the species and their demands for light, moisture, and food be equal.

The claim that any one species has a greater aversion to members of its own household than to that of others is remotely tenable if at all. It is probably true, however, that as some species require less moisture or less mineral food than others, or draw from the soil different food elements, they may be more acceptable neighbors than those of like species. But of this we know little or nothing, and we may safely assume that it will be well to plant pure stands, or, if mixed, mingle such as grow equally rapidly and vigorously in the same situation.¹

It is also claimed that a slow-growing tree may be set out in the forest and allowed to grow for a time and then a more rapidly growing one be placed along with it to serve as a "nurse" tree. If we could even approximately determine the time that should elapse between the plantings, this plan might work well, — if there were anything to be gained, an assumption not well founded, — but we do not know accurately enough the difference in rapidity of

¹ A. C. Forbes, in his recently published *Development of British Forestry* (page 187), says: "At the present time there are three fairly distinct systems in operation in the British Isles — even-aged forest, coppice with standards, and the system of selective felling or uneven-aged high forests, which is worked more often to suit the convenience of the owner than in the interests of good forestry. The first system is practically the only sound system to adopt when returns in the shape of high-class timber are expected." This system is now being generally adopted in European forests.

growth of many of our valuable timber trees to determine when to make the second planting. Some species grow slowly in early life and others rapidly during that period, and the growth of all is more or less controlled by character and conditions of soil and other surroundings. We have no need for guesswork when we know that under like conditions members of each species make practically the same growth in the same time. By planting a pure stand we know we can control the growth of trees to an almost absolute certainty, and such control is of more value than a possible avoidance of disease, or a possible injury to the forest floor; and with our present dearth of knowledge of the peculiarities of the rapidity of growth of our timber trees it will be safe to plant in pure stands, or in mixed stands of equal rapidity of growth. Different species may be put in clumps or clusters, but even then such as may be so planted would best be of substantially the same rapidity of growth, so that the forest will mature evenly and can be harvested on a systematic rotation.¹

¹ An illustration of the result of mingling fast-growing species with slow-growing ones recently came under the author's observation. Several rows of Shortleaf Pine (*Pinus echinata*) and Southern Hard Maples of the same age had been set out in alternate rows, about five feet apart, in an abandoned field, at the same time. The Maples had grown vigorously and were from ten to twelve feet high, but the associated Pines were substantially all dead, and what few were left were stunted and sickly. Only fifteen feet from the outside row of Maples were several rows of Pines, standing alone, which were of the same age as the others and had been planted at the same time, and they were vigorous and fully seven feet high. The only difference in treatment had been that when alone the Pines had no faster growing companions to suppress them with shade or rob them of food or moisture.

VIII

WHERE AND WHAT TO PLANT

IN general terms the area of the United States may be classed as tree-bearing and treeless regions. Much of the tree-bearing portion has been denuded of its forest cover to allow the land to be cultivated, and other portions to supply the needed forest products. Except in the case of the farmer's woodlot no part of the tree-bearing area that is suitable for cultivation should be reforested; but it is manifest that such as is not suitable for agriculture would best be, and to choose what species to plant on any given area is a very important matter. Broadly speaking, it would be safest to plant such as originally grew there, but that is not always easily determined, nor would it always be advisable.

It must not be supposed that any great proportion of the nearly five hundred species of trees indigenous to the United States possesses any commercial value as timber trees, or that many of them are worthy of cultivation. A very large majority of them may be set down as worthless for any economic purpose beyond acting as a cover to the soil, preventing erosion, and, to some extent, aiding in bringing about an equable flow of springs and streams. Some once esteemed of little value are now being largely used. This arises in part from a growing scarcity of better species, in part from the discovery of their value in comparatively new industries, and in part from improved methods of manufacture; and while some are not strictly timber trees their value for other purposes gives them an economic importance that should not be ignored when considering the important trees of our country. Combining those that are useful for what is known as lumber with those used for

other purposes, we certainly have a large list worthy of consideration, notwithstanding that we must discard a great number of species. There should be no anxiety felt about that. The difficulty lies in selecting those best adapted to the soil, situation, and climatic conditions of the area to be forested, coupled with due consideration of the purposes for which they are to be planted, and the demands and needs of the country for forest products. We must not overlook the fact that there will always be a greater demand for certain kinds of lumber than for others, and this should have its weight in determining the selection of species. As is well known, certain species of trees are found in certain localities. Such localities are called the tree's natural range or home. A tree may, and frequently will, grow outside of that locality, and, if so, this enlarged area is known as its botanical range—a region in which it may grow fairly or equally as well as in its original home. White Pine grows as well in Central Europe as here, its home, while our Red Oak becomes more valuable there than with us.

It is certainly clear that in choosing a species one native to the locality should be selected, or one that will grow as well as in its native home, or as the one originally occupying the ground; provided, however, that the tree is such as will meet commercial or other needs. None should be chosen without careful consideration. It may be thought that specific instructions should be given as to where and what to plant. That would be impossible to do safely without personal examination of the designated area. Soil, location, climate, and the object sought must all be taken into consideration, and that cannot be done "at arm's length." In describing, in the following pages, the various species of our important timber trees careful effort has been made to set forth the natural range, soil, region of best development, and general characteristics of each species, from which the attentive reader may form an approximately intelligent opinion. If, after a thorough study of the case,

which should include an investigation of the species of trees that formerly occupied the ground, he still have doubts, it would be best to call in an educated forester, just as he would any other professional man whose services, on account of his own lack of knowledge, he might find himself in need of; for a mistake in this cannot be corrected. But to avoid mistakes and achieve success the future tree-grower should possess a general knowledge of the life-history of trees, what they demand, how they must be grown to produce valuable lumber, and the object for which any one or more species should be planted. To a reasonable degree we should all become practical foresters.

We must not, however, neglect to speak of that other portion of our national domain known as the treeless region. There we encounter a vastly different condition. In a large portion of this now treeless area no trees can be grown except by irrigation. This is owing to absence of rainfall, and all such cases must be considered independently and according to surrounding conditions. Then there are sections of the country, now treeless, where trees have been, and, no doubt, others where they may be, profitably planted and prove a reasonable success. This is especially true of what is generally known as the central treeless region, embracing part of the states of Illinois, Iowa, North Dakota, South Dakota, Nebraska, and Kansas, the prairie district of Minnesota, and portions of Oklahoma and Texas lying west of the hardwood belt. In this region planting is generally successful, but experience — and that can be the only guide — shows that there are but few species suited to any location, and experience must be the guide in selecting these. Throughout that region trees have, thus far, been planted for shelter, general farm purposes, — as posts, poles, etc., — and fuel, because these are pressing necessities, and rapidly growing species have been chosen, few of which are of much importance for lumber. The list is mainly composed of Silver Maple, Cottonwood, Black Walnut, Box Elder, Willows, Ash, — largely Green Ash, — Elms, and Hardy

Catalpa. Few of the conifers — the softwoods — appear to flourish there, European Larch doing as well as any. Fully seventy per cent of the plantations is of the broadleaf species. The tree-planter in that region should carefully feel his way, and local experience should be his guide. There has been considerable planting done in the states named, much of which has been successful, and in determining what to plant this success should be of value.

IX

WHEN TO HARVEST

IN determining the age and dimensions at which a forest-grown tree should be harvested for lumber there are certain features of tree-growth which must be taken into consideration, if the greatest profit is to be realized. These are (1) the ratio of annual increase of available wood ; (2) the waste in manufacture dependent upon size ; (3) the character and quality of the lumber, as affected by age and size ; and (4) the age at which compound interest on the investment overtakes the increase in value, whether from growth or increase in price, or both. The first may be determined mathematically, assuming that conditions of taper of stems and freedom from limbs are alike. The second and third may be approximately determined at any time, while the last is entirely dependent upon the cost of the investment and value of the product in market at the time it is suggested that the forest be cut.

(1) Except for a few unimportant purposes no tree can be said to have a value in market if cut when it is less than five inches in diameter two and one half feet above the ground, a size when it may be said to enter the pole stage. As it grows above that size it can be used for various purposes, and the number of these purposes increases as the tree grows larger and it finally passes from the pole and tie class and enters upon that of the sawmill class. At all diameters from five inches up to the time of its maturity, the amount of wood the tree contains plays a commanding part when determining its value and the time it should be cut, and a knowledge of the amount and the ratio of the tree's increase is essential when deciding to what dimen-

sions it should be allowed to grow, if other features named do not interfere.

In order to illustrate the increase in growth and to determine the ratio of that increase, it will be assumed that the tree selected for illustration is one of the fast-growing species, as some of the pines, and regularly increases one fourth of an inch in diameter each year, or puts on an annual layer of one eighth of an inch in thickness. It is manifest that a slow-growing tree will not increase in contents as rapidly, but the ratio of increase, when based on age, will, if the growth is uniform, show the same results.

The accompanying table shows the diameter of a tree at

Diameter Inches	Age Years	Square of Diame- ter, Inches	Area of Stump Square Inches	Increase Times
5	20	25	19.63	0.00
6	24	36	28.27	1.44
7	28	49	38.48	1.96
8	32	64	50.26	2.56
9	36	81	63.61	3.24
10	40	100	78.54	4.00
11	44	132	95.03	4.84
12	48	144	113.09	5.76
13	52	169	132.73	6.76
14	56	196	153.93	7.84
15	60	225	176.71	9.00
16	64	256	201.06	10.24
17	68	289	226.98	11.56
18	72	324	254.46	12.96
19	76	361	283.52	14.44
20	80	400	314.16	16.00

every inch of growth from five up to twenty inches, the age corresponding to such diameter, the square of that diameter, the number of square inches in area where the diameter is taken, — which is at the stump, — and the ratio of increase of wood contents of the tree from the five-inch up to the twenty-inch diameter. It will be seen that the ratio of increase is based on the mathematical fact that the areas of circles are to each other as the squares of their diameters — in this case that of the tree's stump. Thus a



SECOND-GROWTH WHITE PINE, ABOUT THIRTY YEARS OLD
Jefferson County, Pennsylvania.

tree with a diameter of five inches at the stump contains only one fourth as much wood as one of ten inches, for the squares of their diameters are in that ratio; the number of square inches in area of each proves the fact, and the same law applies to all other dimensions. For instance: a tree twenty inches in diameter contains 1.77 times more wood than one fifteen inches, for the square of their diameters and the number of square inches in their areas are in that ratio. The application of this rule gives an easy and certain method of determining the relative values of different trees. One has only to square their diameters and divide the greater by the less to determine it. An examination of the table shows how rapidly the available wood of a tree increases by age and the importance of allowing a tree to enlarge its diameter. The table is limited to eighty years, for the annual growth usually begins to lessen then, but the principle is applicable to any diameter, irrespective of age.

(2) Lumber manufacturers well know that the relative proportion of waste in slabs and edgings is much greater in a small than in a large log. Most of them use rules and tables giving the number of board feet that can be cut from logs of given sizes, but these take into consideration all kinds of waste, such as crooks, lack of cylindrical form of logs, and other causes, and hence such will not serve our purpose here, where we are discussing only the relative waste arising from different sizes. It is a mathematical fact that the bark surface on a small log is proportionally greater, when compared with its contents, than on a large log. The ratio of waste between small and large sizes is the reverse of that of the wood contents. The circumference — the bark surface — of a log twenty inches in diameter is only twice that of one ten inches, while the contents — the wood — of the twenty-inch log is four times that of the ten-inch one, which fact gives an approximate idea of the relative waste.

(3) As the ratio of waste lessens as the tree advances in

size, the quality and character of the lumber cut from it increase in value. This is generally known by manufacturers, dealers, and consumers. Illustrating this fact, Mr. Edward A. Brainiff, in *Forest Service Bulletin* No. 73, page 20, 1906, says: "The quality of lumber in a tree increases rapidly as the tree increases in size. An eighteen inch tree would hardly be profitable to cut with Yellow Poplar averaging \$23 per thousand. At nineteen inches it would yield an average profit of eighty-two cents per thousand; twenty inches, \$1.32; at twenty-one inches, \$1.99; at twenty-two inches, \$2.67." Without doubt part of this increase in value comes from the increased proportion of heartwood to sapwood, and part from some chemical change taking place in the former. This would be true of all the pines and many of the hardwoods. The change from sapwood to heartwood is not so beneficial in some of the hardwoods, especially Sugar Maple and the Hickories, as with Walnuts, Oaks, Cherry Gums, and some others. As a rule, however, the value of wood increases with the age of the tree.

(4) To determine the period when compound interest on the investment overtakes the accretion in a planted forest is a more difficult matter. European experience shows that from the time of planting up to the age of sixty or seventy years for Pine, Spruce, Larch, and some other conifers, and sixty or seventy for broadleaf trees, the accretion is greater in value than the accumulated cost of planting, care, and compound interest on the investment, but that after the periods named the interest account increases more rapidly than the value of the annual growth. But notwithstanding this fact the cost of labor and the price of forest products in the markets must largely if not entirely prevail in determining when to harvest; and these cannot be known until met. There are many uses for wood when old age on the part of the trees is not so essential as it is for saw timber, and in such cases harvesting can be undertaken much earlier. Still, it must be remembered that to cut a tree for

one railroad tie when, by waiting a few years, it will yield two or more, or cutting wood for pulp when, by waiting another decade, it would yield more than twice the amount, is not good business.

X

THE WOODLOT

To grow trees for fuel and farm purposes is just as much in the line of forestry as to grow them for lumber, and in some respects of more vital importance, especially so to the farm-owners of the country. Fuel is an absolute necessity, and while it is abundant at present, it certainly cannot remain so for long. More than two thirds of our people use wood for fuel, and while the remainder have now either natural gas or coal they must not flatter themselves that those who are to come after them will long be blessed with an ample supply of either commodity. In fact, it is well known that coal and gas are being rapidly exhausted, and in many sections will become entirely so during the life of the present generation. Competent authorities put the limit for anthracite coal at from seventy-five to one hundred years. Long before that time it will become so high-priced as to be beyond the reach of all but the wealthy. Even our immense fields of bituminous coal are not expected to last much longer than the middle of the next century. As it has largely been in the past, so must it be in the future, that wood will be the main dependence for fuel.

The National Conservation Commission made report to President Roosevelt that there were fully one hundred million cords of wood consumed annually in this country for fuel alone. Supposing that from the average acre of the woodlots of the country there could be cut twenty-five cords, — which is probably too high an estimate, — that means the equivalent of clearing off the trees from four million acres of land per annum for fuel alone, to say nothing of the amount cut for posts, poles, or other timber about the farms.

Besides the fuel that the farmer must have he stands in constant need of all sorts of timber for general farm purposes, and there is no more reason why he should send far from home for these when he can produce them on his own land than that he should depend upon other regions, or upon some other than his own country, for his food supply. It is as much in the line of his interests to grow trees as to grow hay, grain, or other farm crops. That he has neglected to do this in many sections of the country, and is still neglecting it, is due, no doubt, to the general and widespread belief that there is an ample supply of forest products, and some to spare, and that there need be no effort made to grow them. But if he has not already learned the contrary he soon will. Experience will be a dear school in this case, and will teach him what observation should have done in years gone by. Hereafter he must grow trees, else he will pay a high price for his fuel and lumber, or go without. He must accept one or the other horn of the dilemma, and it is for him to choose.

It is undoubtedly within the domain of fact that there are not five farms in a hundred in our country that do not have on them from one to twenty or more acres of land that are practically unfit for profitable agriculture, land that is unprofitable for cultivation for ordinary crops, but is well suited for growing trees. Steep hillsides should never be ploughed if it can be avoided. The erosion going on in such cases in this country is a very serious matter. We hear much of the conservation of our natural resources, but in all the din and clamor raised over their destruction but little is said of this greatest of all losses — that of the fertility of the soil by erosion, which is going on in the cultivated and barren fields of this country. Yet we know that every year adds to the already large number of worn-out farms in the older sections, and the loss of fertility from erosion is far greater than exhaustion from the growth of crops. Whenever a stream of roily water flows from a tract of land it carries with it the most fertile portion of the soil.

All this loss of fertility of land unfitted for agriculture, yet subject to serious erosion, can be avoided by planting it to trees; and instead of its growing poorer from year to year, it will be constantly increasing in fertility, and a greater profit from forest products will be secured than if cultivation is attempted.

The species of trees of which a woodlot should be composed need not vary far from those suitable for the production of lumber. It is true that not all such are the best for fuel; in fact, the reverse is somewhat the case, for those which grow most rapidly, and therefore will bring the quickest return in lumber, do not make the best fuel; yet there are few of these that will not produce a very fair article if the wood is properly seasoned and kept under cover after being cut. Weight for weight there is little difference in calorific energy in the wood of our best timber trees. Such species, then, should be chosen for the woodlot as will best serve for all purposes, — for lumber, fuel, posts, and the like. Fitness of species for the location must be a paramount consideration, a matter discussed elsewhere. So, too, the method of growing tree plants and transplanting them has been explained. Such treatment as is suitable for forest culture is likewise suitable for culture for the woodlot. Trees, however, that will make good fuel when advisable to cut them, may be profitably grown in rows or clumps for wind-screens, but such will not be worth much for lumber because studded with limbs from the ground up.

If the farmer possesses a woodlot of any sort its conditions and possibilities should first be carefully considered. It may be possible to maintain or even restore it by natural reforestation, if not too badly cut over; but the chances are largely against that method. To bring that about it must be a close approach to a virgin forest or one in which the cutting has been done judiciously. It is not claimed that selective cutting and natural regeneration cannot be as successfully carried on in a woodlot as in a virgin forest,

but such a condition of the woodlots of our country as would permit that does not prevail to any great extent ; they would last for a time but fail at no distant period. It is easy to make it appear from returns that a forest or woodlot is paying well, but if either is cut faster than it grows the end is bankruptcy. When there is not a full stand of young growth, properly and evenly distributed, the end must come in time, and that time will be determined by consumption.

If the woodlot has been pastured, or if, from other causes, young growth has been destroyed, hope of a restoration by natural processes should not be entertained, even though seed trees may be left standing, as the probabilities are that grass and weeds have so completely invaded the forest floor that germination of seeds will seldom occur, if at all. Under such conditions it may be advisable to plant trees on an entirely new piece of ground fit for nothing else, or to renew the stand on the existing one by growing or purchasing plants and setting them out in vacant places. Unfortunately the practice on woodlots, as well as elsewhere, is to cut the best instead of the defective trees. Where this has occurred it may and doubtless would be best to remove all or much of the present growth, even though the wood be cut and carefully stored for future use, and then plant a new stand of desirable species. It will be frequently found that a few trees with wide-spreading branches may shade large areas. Such should be removed to give light to any growth that may be coming on naturally, or that may be planted. In some cases it may be desirable to plant certain species in partial shade, removing the overshadowing ones as soon as the young growth indicates a necessity.

No special methods of growing a woodlot different from those for growing a forest for timber are required. The same ends are to be sought and the same methods should prevail, for the same principles govern in each case. The object in each is to obtain the greatest amount of valuable wood products in the least time and at the least expense. The same reasons exist for planting desirable species for one as

for the other, and the same necessity for their control is ever present. There can be little question but that the owner of a woodlot would find it to his interest to clear at once more or less of it of any worthless stuff that may be there and plant trees or seeds of such species as will suit his purpose and location. There is no more reason why he should permit useless trees to grow in his woodlot than there is for permitting weeds to grow in his cultivated fields.

A little reflection will show that close planting in the woodlot will be equally as profitable as in the forest, for the reason that then there will prevail the best conditions for merchantable timber, if trees are left for that purpose, and the thinnings will provide fuel and wood for other purposes. By this method there will be secured the fullest yield possible. To leave the distribution of the trees to chance, as in the case of naturally planted forests, should be no more contemplated than for a farmer to use a seed drill that will not do its work properly.

The restoration and perpetuation of the woodlot must be the work of its owner. He cannot afford the services of an expert forester, but must learn for himself just the same, if he be a farmer, as he has learned to do all other things connected with his farm. He should no more depend on unaided Nature to bring forth his fuel, posts, poles, lumber, and other forest products without his supervision and care than he should depend upon her to provide him with hay, grain, and fruit without his direction and labor. He may and should be able to grow his own timber and fuel, and some to dispose of to others.

XI

LIFE-HISTORY OF A TREE

PRELIMINARY to discussing tree-life it may be interesting to the student in forestry to know that by taking advantage of certain laws governing its growth a tree can be made to assume, when mature, such a form as to produce practically all desirable forest products of its kind, but if left to chance for its guidance it may be of little economic value. In one case it may be tall, straight, and free from limbs for a large part of its height, while in the other it will be short in stem, with many large limbs from near the ground up. In one the wood has been deposited in the stem where it is available for lumber, and in the other in the limbs where it is not. Either of these conditions can be brought about when the causes which produce each are understood and the requisite conditions are provided. Nature produces both kinds of trees, and we have but to choose as our needs demand and then obey her laws.

This being the case a knowledge of the laws governing tree-life becomes highly essential, and profitably to grow and care for a forest one should possess a general knowledge of the Life-History of a Tree. An endeavor to give that history and the laws which govern tree-growth will be here made, discarding all technical terms possible and using only those for which there is no substitute.

Flowers and Fruit. The life-history of a tree may be said to begin with the buds which produce the flowers and fruit. The flower may be what is termed a "perfect" one, —capable within itself of producing a fertile seed,—or the organs which perform the functions of fertilization may be in separate flowers, one bearing stamens and the other pistils, being termed respectively staminate (male) and

pistillate (female). The staminate flowers furnish the pollen or fecundating dustlike substance which fertilizes the ovary or seed of the pistillate flower. A grain of this pollen must in some way come in physical contact with an ovary of the pistillate flower or there will be no fertile seed. When mature the pollen is borne from the staminate to the pistillate flower by winds or insects, such as flies, wasps, bees, moths, butterflies, and the like. Nature is very prodigal in the supply of pollen. Probably more than a million grains are furnished where only one does any work. Not only is there an enormous amount of pollen in each male flower, but there are far more male than female flowers on most trees. This is particularly so with Walnut, Hickory, Chestnut, and White Pine. Some of our valuable timber trees, as Yellow Poplar (Tulip-tree), Basswood, and Elm, have perfect flowers, but on most, as with all the Pines, Oaks, Hickories, Chestnuts, and others, the male flowers are borne on separate sprays of the same tree, yet there are some species in which only male flowers are borne on one tree and only female on another. This is notably so with the Ashes and Poplars.

Sowing the Seed. When the pistillate flower is fertilized the seed grows on to maturity, ripens, and is ready to be cast off from the parent tree and begin its independent active life in the reproduction of its kind. But to do this the seed must be scattered where its surroundings are suitable and congenial for its growth, and come in contact with the mineral soil where it can germinate and grow. How the selection of a suitable place in which to grow comes about through natural processes is very interesting. If not scattered there would be no extension of the forests. If no provisions were made for this the seeds would fall under the parent tree where, if they should germinate, they could not live long for want of light, moisture, and food. But Nature has amply provided for the spread of seeds, as has already been noted. In a large class of trees — in which are nearly all the conifers and many broadleaf trees — she



SEEDLING WHITE ASH, ONE
YEAR OLD SHOWING DE-
VELOPMENT OF TAP-ROOT



SPRAY AND STAMINATE BLOSSOMS OF
WHITE PINE



DEVELOPMENT OF WHITE PINE SEEDS

At right are staminate blossoms, next pistillate blossoms, then mature cone,
and at extreme left open cone with scale below showing seeds.

has given wings to the seeds so that when they are ripe and fall the winds will blow them away to other localities. In some cases, as with the Aspens, Willows, and Birches, they are borne miles from their native place, thus permitting undesirable trees to spread themselves and crowd out more valuable ones. With another class, the nut-bearing trees, she calls in various animals — squirrels, mice, birds, etc. — to spread the seeds. These, in their endeavor to store food, drop the seeds on the way to their storehouses, or bury them, and through loss of memory of the location, or by some accident or fright, the seeds are left to germinate and grow. Small fruit, cherries and the like, are eaten by the birds and thus scattered, as the hard kernel in the shell of the fruit can pass through their digestive apparatus uninjured and even seem to germinate the better for such treatment. To add to the certainty of reproduction, Nature supplies a vastly greater number of seeds than are needed. If one in ten thousand grows she is satisfied. But man can aid her by gathering them and planting as many as, and no more than are required, thus subjecting reproduction to comparative certainty while practicing economy, both of which she seems to scorn.

Germination. When the seed is fully ripened and lodged in a fit place, and the demands for moisture, temperature, and covering complied with, the germ — the life-producing feature, about which we know absolutely nothing except its manifestation — asserts its personality and begins the development of the tree. This bursting into life is called germination. At first a growth is thrown downward into the ground to obtain the necessary mineral food and water, and this movement is soon after succeeded by another upward into the air, there to secure certain food from the atmosphere and to enjoy light. The first or downward growth is called the root development, and the other — the unfolding of the stem or trunk, with its branches and leaves — the crown development. For a time the growth of both root and stem is sustained by food that has been stored in

the seed during its growth from the fertilized ovary to maturity, the same as a bird or a chicken will live for the first few days of its life on the substance of the egg from which it sprung.

The root insists on darkness and the stem on light, and neither can be made to abandon that determination, nor can the root be made to grow upward or the stem downward. The functions of the root are twofold. One is to gather the moisture—the sap—and with it the necessary mineral food held in solution therein—potash, lime, phosphoric acid, etc.—which constitute approximately one half the weight of the tree, and to send these up through the little pores or ducts in the roots, stem, and branches to the leaves, where they meet with the food the leaves gather from the atmosphere, and where the two combine and are practically digested through the agency of a green substance known as chlorophyl,—a process which is wonderful and not fully understood,—producing a perfect food for stem, limbs, roots, bark, leaves, flowers, and fruit, to each of which it is sent in a mysterious way. The other function of the root is to hold the tree upright.

As the roots penetrate the soil they throw out little hairs covered with microscopic mouths to suck in the moisture containing the dissolved mineral food which they seek; and the roots travel abroad in the ground in search of it, going a great distance. A tree growing in the open will send its roots out as far as, and sometimes farther than, its limbs extend, while they have been known to go downward more than twenty feet. After a season's growth these little hairs mainly die and the tree takes a rest, and in a certain class called deciduous trees the leaves die also and drop off annually. With some evergreens the leaves stay on several years, but all of our timber trees, except those growing in the tropics, insist on taking a rest a part of each year. Few new hairs with their cells grow on that portion of the roots once occupied by them, but a new growth of roots must take place each year, springing out from those of former

years; thus the roots become elongated, but in a different manner from what occurs with the limbs. The new growth of roots, as well as that of the buds, leaves, twigs, bark, etc., of the stem, is furnished with food — until the little hairs can begin their work in the spring — that had been stored up in the cambium layer on the stem, limbs, and roots during the late growth of the previous year, substantially the same as food had been provided in the seed for the young to subsist on until the leaves are developed and all the functions of tree-life have become active. In order to protect themselves from injury the roots, as well as stem and branches, put on a coat of bark.

The Sap. The circulation of the sap of a tree — the water with mineral food in solution gathered from the ground by the little rootlets and carried upward and outward to the extremity of the branches — is more wonderful, more complicated, and less understood than the circulation of the blood in animals. In animal life the muscular heart literally pumps the blood through the arteries, at the same time drawing it from the veins. In animals there are separate channels for the circulation of the blood, one for the incoming to the heart and the other for the outgoing; but it is not known, though it is probable, that some certain ones of the pores or ducts in the wood of trees serve as passageways for the sap and mineral food to the leaves and others for its return to appropriate places after digestion. It is done in some way, but we do not know just how; possibly the digested food is carried back through pores in the live bark. Neither is there anything akin to a pump to be discovered in a tree or other plant life. The roots take in water, and by some unknown process, it climbs upward to the tops of the tallest trees, apparently as easily as it does in a diminutive plant. Redwood trees are frequently found three hundred feet in height. A column of water that high will produce a pressure at the base of nearly one hundred and fifty pounds to the square inch. Evidently there are resting-places along the way, or something that shuts off the pres-

sure, or the cellular tissues of the wood would be ruptured. Just how this ascent of sap to such great heights as we know it attains is brought about we do not yet understand. There are various explanations, but each one of them has a weak link in its chain.¹ Notwithstanding that we can see no active life in a tree in winter-time, yet it is certain that the sap ascends then, for if from any cause, such as dry or deeply frozen ground, moisture cannot be obtained by the roots for a long time, the tree will frequently be killed, because evaporation goes on through the pores in the bark and, in the case of evergreens, through the stomata or breathing-pores in their leaves.

Stems and Leaves. Having now seen the functions and the growth of the roots, attention will be given to the stem and leaves to see what part they play in the economy of tree-life. The ascent of the sap to the leaves, carrying with it the mineral food, has already been noted, and a description of the leaves and the functions they perform will be necessary to comprehend fully the growth of the tree, and especially the character of the stem from which lumber must be cut. The leaves of all trees have a framework of fibrous material called veins. The largest of them are prominent and plainly visible to the unaided eye. In broadleaf trees they are quite so. Close inspection will show that in some leaves there is a fine network of them. This network is technically called the leaf's venation. These veins are inclosed between two films known as the epidermis or leaf's skin. There are small holes in the skin of the leaves, and in broadleaf trees they are much more numerous on the under than on the upper side, but in some of the conifers there are about as many on one side as the other. They are

¹ "The principal cause of the upward movement of water is unknown. The most divergent views are held, not one of which has proved capable of satisfactory demonstration. . . . It is hardly possible to deny the existence of root pressure, capillarity, and the lifting power of evaporation and osmotic pressure. The relative importance of these, the manner in which they work, and the existence of other factors are points that it is impossible to settle at present." — *Plant Physiology and Ecology*, by Frederick Edward Clements, Ph.D., page 56.

not visible to the naked eye, as they range in number from 800 to 150,000 to the square inch, varying with species. The name stomata has been given them, and, as will be seen, these little holes play an important part in producing trees that will yield good lumber. Through them is admitted air where it comes in contact, in the chlorophyl, with the sap sent up by the roots and distributed throughout the leaf by the numerous veins. In some way, through the action of the chlorophyl, the carbonic acid gas which is mingled with the other gases of the atmosphere and named carbon-dioxide, combines with the mineral substance brought up in the sap, and these inorganic substances are changed into organic ones. They are, practically, digested and converted into available food, which neither was before the combination took place. Just how this is done is not known, nor as stated, is it fully understood in what manner, or through what channels this prepared food is sent back from the leaves through or along the stem and all the branches and roots, leaving in their proper places in its passage such particular food as goes to make wood, bark, leaves, buds, flowers, and fruit.

The Stomata as Breathing-Pores. In addition to admitting the air to the chlorophyl lying between the two surfaces of the leaves, the stomata serve to let the excess of water, which was necessary to carry the mineral food from the roots to the leaves, evaporate and escape. This is called respiration, and the amount of water some trees give off when growing vigorously is astonishing. They also serve to let the oxygen, which has been rejected in the process of preparing the food, escape, thus literally serving as breathing-organs or mouths. The main difference between tree and animal breathing is that the tree exhales the oxygen and retains the carbon, while the animal rejects the carbon and retains the oxygen. If the tree could not throw off the oxygen, it would be practically smothered and would die, while the same end would come to the animal if it could not get rid of the carbon.

The Stomata must have Light. We have already seen that the stomata, the little pores in the skin of the leaf, literally serve as mouths to take in air—a portion of which is consumed as food—and reject what is not suitable, and that they also permit the escape of the surplus sap that comes to the leaves from the roots. But all this is neither so wonderful nor so important as the further fact that they must have light in which to do their work. They close in the absence of light and open only as light is given them. At first thought this feature will appear of little moment, but, when fully understood, it will be seen that it has a controlling influence in the production of merchantable lumber. When trees are grown in the open, ample light comes to all their branches, or, at least, to their extremities; but when crowded and the leaves on their limbs are deprived of light, those so deprived are literally starved to death, for the stomata are closed and no carbon can mingle with the mineral ingredients to form food, nor can the poisonous oxygen be exhaled. The result is that the limbs that are deprived of light are not only starved but actually smothered; and consequently die, decay, and drop off, leaving a smooth stem free from limbs and knots, from which first-class lumber can be cut.

A tree grown in the open, where neither roots nor branches are crowded in any way, will naturally throw out limbs soon after emerging from the ground, and these will grow until deprived of light by limbs springing out above and reaching beyond them. A struggle for light is then begun and each limb naturally seeks to obtain it and consequently lengthens; but the small branches, which in the early life of the limb had light, are more or less deprived of it and die, with the result that the foliage of the tree is mainly on the outer ends of the limbs, which are frequently long and large. Such trees yield but little lumber, for the wood is largely in the limbs instead of in the body of the tree, and what it does yield is of little value, for it is filled with large knots.

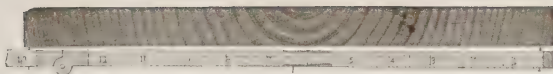
If light cannot be obtained for the lower limbs, the stems climb upward to secure it and tall trees free of limbs near the ground are the result. As there is a continual struggle for light and food, it is the province of forestry so to regulate conditions that the best results will be obtained without unnecessary expenditure of effort or exhaustion of vitality of the tree, and at the same time to encourage the struggle sufficiently to secure the desired end. In other words, to so arrange for light, mineral food, and moisture that the surviving trees will not be compelled to wage a greater warfare in suppressing weaker ones than is absolutely necessary to produce the requisite character of lumber. This can be done by proper planting and thinning.

Growth of Wood and Bark. As the substance required for wood goes back from the leaves there goes with it that which makes the bark, and while a layer of wood is deposited on the outside of the stem, branches, and roots each year,— we are considering only those trees which thus make their growth, the exogens, for they are the only real timber trees,— there is likewise a thin layer of bark deposited, which, however, is separated from the wood by what is botanically known as the **Cambium Layer**, a viscid secretion that intervenes between the last formed layers of wood and bark. This layer not only separates the wood and bark, but at the end of the season's growth serves as a storehouse for food on which the buds and roots draw in the beginning of the next year's growth, or until the leaves and roots are developed enough to themselves obtain food from the atmosphere and soil. The wood deposited is known, when mature, as the **Annual Rings**. These are very distinct in some species, but quite obscure in others, and in some tropical species not discernible in either wood or bark. In most of our timber trees the wood first deposited is porous— filled with ducts and cells for the flow of sap. These are conspicuous in some species, as in Ash, Oak, Chestnut, Elm, and some others. This cellular, first-deposited accretion is denominated the **Spring Wood**. As the sea-

son advances the number of cells lessen and the wood becomes much more compact and in most species harder, and this is called the **Summer Wood**. In some species there is such a distinction in color, porosity, and density between the spring and summer wood that the annual rings can be distinguished without difficulty, and these features more or less affect the character of the wood. As a rule the annual rings indicate the age of the tree, but not always. If a drouth occurs in midsummer, growth will be arrested, and apparently a normal ring will be formed; but if wet and warm weather then succeeds, growth will be resumed, and another but thinner ring will be laid on quite similar to the first. This, however, does not frequently occur, and the number of rings is a fair guide to the age of the tree.

Heartwood and Sapwood. While carrying the mineral ingredients of the tree's food to the leaves the sap is restricted in its passage, possibly in part to the live portion of the bark, but mainly to a limited number of the youngest annual layers of wood. These vary in number with the species of trees, and also with the conditions environing each individual tree of any given species, but as a rule they are quite uniform in each species. That portion of the tree through which the sap passes is called the **Sapwood**. After serving for a time for the purposes named, a change takes place in the innermost ring of the sapwood and the sap no longer flows through it, and it then becomes what is known as **Heartwood**. After this change occurs, that portion of the tree ceases to perform any life functions. For nearly all purposes it is dead, and the only service it thereafter renders is to support the growing portion of the tree and prevent its destruction by winds. All the heartwood, as it frequently does, may decay and the tree remain alive and be nothing but a shell of sapwood. In most species the color of the heartwood is darker than that of the sapwood, but not in all, for in some the reverse is the case, and in others there is very little or no difference.

For nearly all purposes heartwood is preferred to sap-



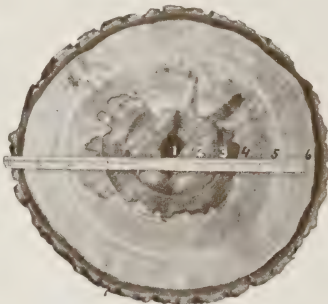
Section of a White Pine Board sixteen feet long, without wane or sap, nearly free from knots. Annual rings at stump showed tree to have been seventy-five years old. Tioga County, Pennsylvania.



Section of a joist two and a half inches thick and fourteen inches wide, cut from Old-Field Pine, showing marked difference between spring and summer wood. Southern Virginia.



Section of Red Oak, four by four inches, showing medullary rays and annual rings.



Section of Carolina Poplar six years old. Annual rings indicated by figures; intermediate rings caused by alternate wet and dry weather. Note how irregularly heartwood is shaped. Reynoldsville, Jefferson County, Pennsylvania.



Section of White Ash sixty-eight years old: roots on side of least growth were deprived of air and moisture by watertight brick pavement. State Capitol Grounds, Harrisburg, Pennsylvania.—*Courtesy of Pennsylvania Department of Forestry.*

wood. The former is more durable when exposed, is stronger, shrinks less in drying, and is heavier and more compact, the latter feature arising, no doubt, from the pores and ducts being filled with gums or other solid matter. There appears to be some irregularity in the change from sapwood to heartwood, but just why is not known. Practically all species are subject to it. Usually as a new ring of sapwood is laid on there is an inner one changed to heartwood ; but this does not invariably occur, as some trees of the same species may and do have more sapwood than others, and more towards the top than at the butt, or the reverse, and even more on one side than on the other. With some species of trees this change to heartwood does not occur until the tree reaches thirty or even seventy-five years of age, while in others there are seldom more than six or seven annual rings of that kind of wood. They generally lessen in number proportionally in all species as the tree reaches maturity and old age. The whole matter appears to be involved in more or less mystery. It appears to be an effort of Nature to discard that for which there is no further use, just as she discards the dead outer scales of bark.

Pith and Medullary Rays. Another interesting feature in tree-growth is the pith in the centre of the stem and all the limbs, and the thin sheets or rays radiating therefrom. The pith is a small, porous, and somewhat spongy cylinder of cellular tissue, and what purpose it serves in the economy of the tree's life is not fully known, if at all. The glassy sheets radiating from the pith are technically known as the **Medullary Rays**. They are harder than the pith and sometimes harder than the surrounding wood. They can be found in all of our timber trees, but are more conspicuous in some than in others, and where plainly visible are deemed to add beauty to the wood when it is used for interior finish and furniture. They do not run uninterruptedly the entire length of the tree, but are broken up into short, irregular patches and are seldom more than six or seven inches long. The major portion of them radiate from and

are connected with the pith, although broken more or less as they recede therefrom. The microscope shows, however, that all are not connected with the pith. They show independently in the bark of some species. The common names given them are "mirrors" and "silver sheens." It is well known that most woods will split more evenly and readily on lines radiating from the centre than tangentially. This is undoubtedly brought about by the medullary rays. It is also known that in seasoning, woods begin to check in these rays.

The Bark. It has already been stated that when the digested food travels back from the leaves and puts on a layer of wood on the stem, branches, and roots, it also gives a layer of suitable material to the inside of the bark on both stem and root development. This is necessary because the size of all parts is constantly increasing and more expanse of bark is required each year to cover the whole. As the tree grows the distance around it increases, and as the bark is only slightly elastic it necessarily cracks, and new bark must be grown or the tender wood will be exposed and the cambium layer so interfered with that a new layer of wood cannot be grown through its good offices. As the inner rings of the sapwood practically die as they change to heartwood and perform no further functions in the life of the tree than that of protection, so a similar change takes place in the bark, except that the outer layer dies and a new inner one is formed, the latter serving the purpose for which it is designed, which is that of aiding in the distribution of food and protecting the parts it covers from injury. It must be admitted that some of the functions of the bark are not yet fully understood, but enough is known to determine pretty well what takes place. As already stated, there is an annual addition to the inside of the bark, and for a time in the life of a young tree there is no death of any bark layers; but as the stem, branches, and roots grow the bark fails to expand with the growth, and the outer or oldest layer cracks, and when that occurs the death of such layer fol-

lows, but a new one is taken on at the same time. Sometimes the dead layer falls off annually, as with the Sycamore and Paper Birch, but generally it changes into a corky condition and adheres as the tree expands. As this occurs the dead parts arrange themselves in more or less vertical valleys and ridges, although in some trees the dead bark cracks irregularly and in patches, in which case it generally falls off in scales in a few years after its death; hence some trees show a thinner bark than others. The inner layers are called the live and the outer ones the dead bark. There is quite a plain line of demarcation between them.

In some species the annual layers are much thicker than in others and are distinctly shown in the dead bark when cut radially from the heart of the tree. The bark of some trees contains chemical properties, such as tannic acid — an astringent much used in tanning leather — and other useful ingredients, and on that account may have a commercial value. This is especially true of the Eastern and Western Hemlock and some of the Oaks, notably the Chestnut Oak. While the live bark is the most heavily charged with tannin it does not rapidly disappear from the dead bark. Old Hemlock bark retains its tannin for a long time.

An interesting experiment which discloses something of the process in the deposition of the material constituting the bark may be made by carefully removing some of the bark of a tree at the time of the tree's most rapid growth in early summer, when the bark most readily separates from the cambium layer, then active in distributing both wood and bark materials, which are then soft and easily placed. If the exposed surface of the cambium is carefully shaded, or the weather is moist and cloudy for a few days, a coat of bark will be formed over the entire surface that has been exposed, — providing the cambium has not been bruised or broken, — and the wood and bark growth will go on under the new bark the same as if the old had not been removed. A young and thrifty tree can, at the time of its most rapid growth, be completely deprived of its bark for

several feet in height and recover, if the cambium is carefully protected as indicated. In shading the wound care must be taken to keep the enveloping material from coming in contact with the cambium, for wherever it touches the bark will not form.

A great mistake is made by applying to the wound paint, oil, dirt, or other substance, when some of the bark of a tree, at the time of the most rapid growth in early summer, has been removed by accident. If the lacerated spot is shaded by wrapping colored paper or cloth around it, shutting out the sunlight and wind, the wound will almost invariably be coated with new bark, and little practical injury be done to the tree. If the wound is made late in the summer there will be no bark formed and then the wound would best be painted to exclude every species of fungi.

The peculiar characteristics of the exterior bark of trees give a fairly good guide in determining the species. Thus no Oak need be mistaken for a Pine, nor a White Pine for a Yellow Pine; but in some cases there is so close a resemblance that the cursory observer may be mistaken. At an advanced age the bark of a Hemlock somewhat resembles that of a White Pine of the same size, and the bark of a Red Oak and a Black Oak are very similar. An expert may not be mistaken in any case, but all cannot be experts, and such as are not should learn to know the trees the same as they do a person, not by any minor detail or particular feature alone, but by their general make-up, their forms, general features, etc.

While we have a comprehension of nearly all of the features of tree-life and can understand how certain things are brought about, there is one which has much to do with the value of the lumber that a tree may produce that is wholly inexplicable. This particular characteristic is the irregularity of the direction of the grain or fibre composing the substance of the wood, as noted on page 80, but there considered only as it relates to commercial or industrial features. There are two kinds of irregular grain or

fibre quite distinct from each other. As noted, one is where they are irregularly interlaced and are not parallel with each other, and the other is where the grain is practically parallel with itself, but winds spirally around the axis of the tree. There is no dictionary word for the former, but woodworkers say it is "eaty," meaning that the fibres work or eat their way into the wood as a worm eats its way into fruit. The interlacing of the fibres is invariably found in some species, as in the Sycamore and Tupelo. In others it appears occasionally. It adds to the beauty of such as are used for interior finish and furniture, as those portions of the surface which show the ends of the fibres are, when finished, darker in color than those showing the sides, the color varying with the angle in which the fibres are presented. This irregularity does not materially lessen the strength of the wood, and for some purposes cannot be looked upon as a defect, while for others it enhances its value, but makes it difficult to work.

The other irregularity is designated as "winding," that is, the fibres or grain "wind" around the stem or trunk; and when the lumber is cut parallel with the tree's axis from such a tree, the grain necessarily runs across the board or stick, which makes it not only hard to work but weakens it, and the value of the wood for some purposes is seriously affected, especially if the wind is great. A board cut from such a tree may be so cross-grained as to be easily broken, — practically be split diagonally across, — and a stick used for vertical support is weaker because of the tendency of the fibres to part and the stick to collapse. Such timber is rejected by the competent engineer where great compressile strength is required. The tendency of such lumber to warp in seasoning is noted elsewhere. Neither of these irregularities is uniform in any species. Individuals of the same species are differently affected. Some trees of some species are practically free — but few entirely so — and others are greatly affected. No one claims that there is any law manifest in the case of irregular and

tortuous interlacing of fibres, but it is erroneously claimed by some that there is a uniform law shown in spiral winding, and that the wind is always in the direction of the sun's course in the heavens, that is, from east to west on the south side of the tree and consequently in the opposite direction on the other side. An examination of a large number of peeled Hemlock logs, cut in localities far apart, during twoscore years of lumbering experience, — this tree being more given to that kind of irregularity than almost any other of our timber trees, — shows that about ten per cent was without any wind, approximately twenty per cent with the sun and seventy per cent against it. No law appears, in the case of trees, to govern in either irregularity, although, as a rule, climbing plants twine against the sun; nor is it known that any treatment of a growing tree can in any way modify or change the wind. It would be well for the Government to undertake the task of finding out whether winding is hereditary, for if growing trees from seed of only such as are straight-grained will produce others of like condition, much good would come from it.

XII

CLASSIFICATION AND CHARACTER OF WOOD

THAT it may be understood why certain peculiar features and characteristics of the wood of each of the several species of trees described in succeeding chapters are mentioned in detail, it is deemed advisable to define, in a general manner, the meaning of the terms used, and also to indicate the qualities or features which such terms cover or represent; for upon these qualities and features depend the tree's value. It must be plain to all that a knowledge of the particular features of the wood of each species of trees, and its adaptation to the uses to which the wood is or can be put, is essential in determining what kinds to grow; and such knowledge must be had before an intelligent course can be decided upon.

Softwood — Hardwood. Generally speaking, the timber trees of our country are classed as "Softwood" and "Hardwood," and however much or little this division may vary from fact the distinction is universally made in the lumber trade. Yet, when we consider the trees placed in each class by the lumberman, we can see that the terms are not in accordance with fact. Some are classed as hardwoods when the wood is actually softer than that of some which are classed as softwoods. To speak of the softwoods of the lumberman as "conifers" would be correct in fact, for that they all are. It would not be correct to speak of the lumberman's softwoods as "evergreens," for Cypress, Larches, and Tamaracks are all classed among softwoods and are all conifers, and they are deciduous, — they shed their leaves in autumn, — while the Holly and Live Oak are evergreens, but are strictly hardwoods, and are so classed.

Fortunately, however, what constitutes a softwood tree has been defined by a recent decision of the courts which holds that "any tree that has a needle-like leaf is a softwood"; and under this distinction it will be fair to assume that all others are hardwoods. It is not claimed that this decision is based upon actual character of the wood, but upon a prevailing classification, by lumbermen, which is of so long standing that it amounts to a universal custom of which the law will take cognizance. It should be understood, however, that when the author speaks of the wood of any given tree as "soft" or "hard," he refers to the actual properties and not to the classification designated by the judicial decision; as, for instance, he calls the wood of Sugar Maple hard and that of Basswood soft, while both belong to the class of legal hardwoods. So, too, the wood of the Longleaf Pine is spoken of as hard, — that is, hard for a pine, — while it is legally placed with the softwoods, and this rule pertains to all species of trees considered.

Fine-grained — Close-grained — Coarse-grained — Cross-grained — Straight-grained. All these terms are more or less used by lumbermen, woodworkers, and authors denoting certain characteristics of wood. In order to understand their meaning, it will be well first to determine what constitutes the "grain." Unfortunately the dictionaries are not very explicit in definition nor are they in complete accord with woodworkers and lumbermen respecting its meaning when applied to wood. The nearest approach to an agreement is the definition of "grain" given in the *Century Dictionary*, where it is defined as "fibrous texture or constitution, especially of wood; the substance of wood as modified by the quality, arrangement, or direction of its fibres: as, boxwood has a very compact grain; wood of a gnarled grain; to plane wood with, against, or across the grain." The same authority defines fibre as "the narrow elongated cells which characterize the woody and bast tissues of plants, giving them strength, toughness, and elasticity." While giving due importance to the direction and arrangement

of the fibres the woodworker and lumberman take into consideration the size and number of cells or veins and their arrangement, and to some extent the difference in density and compactness between spring and summer growth.

Fine-grained — Close-grained. These are practically synonymous terms and are applied by the lumberman and woodworker to wood with small, inconspicuous, and evenly distributed pores or veins. In some woods these are so small as to be barely visible, if at all, to the unaided eye, and the fibres are compact and close. Such wood is not necessarily hard. Cedar is fine-grained but soft; boxwood is fine-grained but hard. Schlich, in his *Manual* (volume v, page 83), defines fine-grained wood as “wood that can be easily worked, whether or not it appears so to the eye. It is not equivalent to narrow-zoned — annual rings — nor to anatomical simple structures.” This takes into consideration the fineness and even distribution of fibres and veins. Such wood may be hard yet easily worked because of its uniform density.

Coarse-grained. With the woodworker this term is practically the opposite of fine-grained. It applies where the ducts or veins are numerous, coarse, and unevenly distributed. In some woods the spring growth shows numerous large veins, while the summer wood has only small and inconspicuous ones — notably the Oaks, Ashes, Chestnut, Elms, and some others. Such woods may be either hard or soft, but they may be, and generally are, hard to work because of their unevenness in density.

Cross-grained. Strictly speaking, this term applies to wood where the fibres are not parallel to the axis of the tree from which it is cut, as explained on page 77. It is also given to wood where the fibres are not parallel to each other but are tortuous and interlaced.

Straight-grained. This applies to wood where the fibres are parallel to the axis of the stem of the tree. Such wood is stronger than if cross-grained and is hence more valuable. As a rule it can be easily split and more readily

dressed to a fine, smooth surface, although not esteemed as beautiful when finished without paint.

Strength of Fibre. Irrespective of the direction or density of the grain or fibre of wood there is a peculiar feature in some wood which adds much to the value of trees possessing it. This is termed its **Strength of Fibre**, and is that characteristic or quality which fits the wood for the manufacture of what is commercially termed "pulp," from which paper, celluloid, cardboard, and many other useful articles are made. Some species of trees are conspicuously adapted for this and others are not. The poplars stand at the head of the list for pulp for paper, and next after them come the Spruces, Firs, Balsams, Hemlocks, Pines, and some of the broadleaf trees, as Basswood, Yellow Poplar, and some others.

Seasoning — Drying — Checking — Warping. These features are so intimately connected with each other that they need not be separately discussed. The first two terms are practically synonymous and will be so used. Webster's definition of seasoning is, "To prepare by drying or hardening, or removal of natural juices; as, to season timber." It is a well-known fact that when wood is cut from a live tree it is heavier than when seasoned — that is, heavier than when the moisture in the pores or veins has been dried out. The results which arise from seasoning have much to do with the value of the wood and hence become an important economic feature. Unless used where continually saturated with water, all wood is more serviceable if seasoned, and the rapidity with which that can be accomplished, and the freedom from injury in bringing that about, play an important part when we determine what trees to plant.

As has been explained (page 66), the pores or veins carry the sap from the roots to the leaves, and hence have more or less moisture in them all of the time. Before seasoning there is always more moisture in the sapwood than in the heartwood, and therefore wood from trees with a large amount of the former is more difficult to season than the

latter, and consequently the wood shrinks more in drying. The pores in the heartwood are more or less filled with gum, tannin, and other substances, yet are never without moisture until thoroughly seasoned. When the moisture is evaporated the wood necessarily shrinks, the fibres become more compact, it becomes stronger, — not necessarily tougher, but, on the other hand, more brittle, — harder, and more serviceable. Evaporation of the moisture proceeds most rapidly from the ends of the pores or veins when exposed — although in but few woods are they continuous; hence a board or stick will dry more quickly at the ends, and, shrinking faster there than elsewhere, cracks are liable to occur. Consequently, to prevent unequal shrinking, and the resultant checking, evaporation should go on evenly over the entire surface. To avoid checking through the unequal evaporation of the moisture they contain, logs of valuable species, such as Black Walnut, Ash, Cherry, etc., are frequently painted at the ends as soon as cut.

The moisture in the fibres and pores of the wood is not compelled to pass out through the ends of the wood alone, as it can and does escape elsewhere. Unfortunately the escape of moisture is not uniform in any species of wood, but may be greater in some parts than in others; and this gives rise to irregular shrinking, which results in warping and twisting of the stick or board, — which is a very serious defect even if checking is avoided. It is greater in some species of wood than in others. This irregular drying, and consequent irregular shrinking and checking, are largely brought about — but not entirely so — by the fibres not running parallel with each other. As has been shown, the fibres of some species of tree are much distorted and run in various directions, twisting and interlacing, and when lumber is sawed from them the open ends of the pores are presented and evaporation takes place more rapidly there. Shrinkage endwise will occur in cross-grained wood practically in the ratio of the departure of the fibres from parallelism with the axis of the stick or board.

Checking and warping of some woods when seasoning baffled manufacturers for a long time, and, until methods were discovered whereby it was overcome, many woods were esteemed of little value. But much has been gained in that direction, and dry-kilns now obviate such difficulties to a great extent. They suppress even the exudation of gums and pitch from some woods so that they can be painted or otherwise finished without danger of disfigurement from that source. Experience shows that all wood can imbibe moisture after being seasoned, — some more than others, — whether it comes as a direct application of water or from a humid atmosphere. Whenever that occurs the wood immediately swells and, in common parlance, “will not stay put.”

It is a singular fact, but one well known to woodworkers, that no matter how long or how thoroughly a piece of wood may have been seasoned, and notwithstanding it may practically have neither shrunk nor swelled during its use, yet to dress off the surface with a plane or otherwise will cause the piece to shrink again. Whether there is still moisture in the wood which can escape after the thoroughly dried surface is removed may be a question, but probably that is the case.

Decay. It is well known that some woods decay more rapidly than others. As here used, decay does not include wearing away of a surface when exposed to the action of the winds, water, or frost, but a breaking-down of the cellular structure from and through diseases brought into it by some of the various species of fungi. Wood of some species of trees resists these attacks better than others, and this power of resistance in a large measure establishes its value for exposed situations. Were a fence post, telegraph pole, or railroad tie cut from a Paper Birch capable of resisting decay equal to that of a Locust or Catalpa, the value of the Birch would be far above what it is. Thus a knowledge of the resistance to decay aids in determining what to plant.

Strength. The power to resist breaking or crushing is another very desirable feature in wood. For many purposes this determines its value. White Oak and Hickory are well known for their strength and endurance when subjected to great strain and heavy burdens. Weight for weight they are nearly as strong as cast iron in resisting transverse strains. This eminently fits them for some purposes, for which other species would be worthless. It must be remembered that all the wood of a tree of any given species is not of equal strength. Some Oaks may have no greater strength, for equal dimensions, than White Pine or Yellow Poplar; but this arises from conditions surrounding the tree in its growth. The wood of some parts of a tree may be stronger than that of other portions. Soil, location, age, suppression by other trees, and subsequent relief from that, may greatly modify the character of the wood produced. Therefore, the best that can be done in describing the qualities of any wood is to speak of it in its average condition, as, for instance, to say of an Oak or a Hickory that it is tough, strong, hard, etc., or of some other species that they are weak, soft, and brittle.

Color — Texture. The color, texture, and general appearance of wood when used for furniture, interior finish, or in other protected places where it is to be seen, are important features and have much to do with its value. Though somewhat harder and more durable than Yellow Poplar, Black Walnut would be of little more value than the Poplar were the beauty of its color and texture covered with a coat of paint. Some woods have a rich, satiny, and transparent surface when finished without stain or paint, and modern taste has come to appreciate these qualities. Some will take stain well, by which they may be made to resemble closely woods of superior character, and some will take paint or glue better than others, all of which are important features.

Medullary Rays. The wood of all trees has medullary rays as elsewhere described. In many species they are small and inconspicuous, but the possession of them by a few

adds much to their importance, notably all the Oaks, the Sycamore, and several others in a lesser degree. Woods in which these are prominent and conspicuous are generally "quarter sawed" in manufacture, that is, sawed radially — from centre to circumference — so as to display this feature. When sawed tangentially — at right angles with a line drawn from centre to periphery — it is called "flat," "plain," or "bastard" sawed. The latter method displays the prominent features arising from the difference in color and density between spring and summer growth. This distinction is further emphasized in finishing with colored "filling," which darkens the pores of the spring wood and makes them more conspicuous.

All of the features here noted, and some of less importance, add to or detract from, as the case may be, the value of woods, and should be considered when determining what to plant. Although some of the nut-bearing trees have additional value on account of the fruit they bear, and others in the resin, gum, or tannin in the bark or wood, or other like properties, such features do not have any very important bearing in deciding what trees to grow for timber, but they may aid somewhat in determining what to choose. The fact, however, should be recognized that trees grown in the forest where they must be crowded to produce good timber bear little fruit at best, and that not until late in life.

XIII

THE FOREST NURSERY

PLANTING or sowing seeds where the trees are to grow to maturity is frequently advisable, and in some instances and with some species, may prove to be the most satisfactory method, but experience shows that growing certain kinds in a nursery and, when large enough, transplanting them into the forest is far more likely to be successful. The reason for this is that in the nursery the young trees are protected and cared for until they are large enough to contend successfully with the adverse surroundings which they are almost certain to encounter in early life from the presence of brush, weeds, and grass that almost invariably exist on the ground where the forest is to stand. Only on limited areas can tree seeds be planted where the forest is to grow without the tiny and almost helpless seedlings encountering unfavorable conditions which will render them liable to be greatly retarded in growth or killed outright. We know full well that our farm and garden crops must be protected from weeds in early life,—and should be at all ages to be profitable,—and it is precisely the same with young trees.

It may appear paradoxical but it is an established fact that many species of trees can be grown from seed in a nursery and properly treated there until three or four years old,—their sojourn in the nursery to depend largely upon the species,—and can then be set out in the forest, where they will, at the end of six or eight years, be larger, more vigorous, and better able to withstand encroachments upon their domain, whereby they are robbed of moisture, food, and light by worthless and greedy vegetable growth, than will be those of the same age from seed sown or planted in pre-

cisely like situations. But this is not true with all species. Some have what is designated a tap-root, — among these are a few of the conifers and many of the broadleaf species, — and the deprivation or severe mutilation of that feature is sometimes fatal, and in all cases retards the growth. Such would best be planted where they are to grow to maturity, although some of them can be transplanted without serious injury. In addition to being relieved from adverse surroundings a young tree grown in a nursery develops a fuller and better root system than when standing among worthless hungry neighbors. This is especially true if it can be once transplanted in the nursery and given more space in which it can grow for one, two, or three years. To grow trees in a nursery until they are large enough to be transplanted into the forest is no more difficult than it is to grow most garden vegetables. The length of time required is the most important difference.

As the nursery is the basis upon which any considerable advancement and success in forestry in the future of this country must rest, — and the experience of European countries shows that it is so there, — a full description of the methods which experienced nurserymen have found most advisable, together with suggestions for removal of the little trees from the nursery and planting them into the forest, is surely justified, although it may require considerable space. The professional nurseryman may not find much in this relation that is new, but what he will see is based upon actual experience as exhibited in the largest and best forest nurseries; and to it is added the careful and diligent personal observation and experience of the author. Reasons for doing this or that thing are given and the reader can judge for himself whether they are sound. While large areas are dealt with, an intelligent understanding will observe that small ones are to be treated in substantially the same manner.

In explanation of the terms used it should be stated that a "seed-bed" is that part of a nursery where the seeds are



**NATURALLY GROWN WHITE PINE SEEDLINGS, TAKEN FROM
ABANDONED FIELD**

The one at extreme left is one year old; the others are two, four, and five years respectively. Note the lack of fibrous root development, especially next to stem.



NURSERY-GROWN WHITE PINE SEEDLINGS AND TRANSPLANTS

From right to left: one-year-old seedling; two-year-old seedling; three-year-old transplant, removed from seed-bed at two years; four-year-old transplant, removed from seed-bed at two years, seven inches high from top of root system to terminal bud. Note good root development, especially in the transplants.

sown ; that the little trees grown in the seed-beds are termed "seedlings" until removed, which event may occur when they are, one, two, three, or four years old. The "transplant nursery" is the ground to which the seedlings are removed in order to develop their root system and make them able to achieve victory in their struggle when set out in the forest. After removal from the seed-bed to the transplant nursery the little trees are known as "transplants." Seedlings and transplants are, for brevity, designated "plants."

Location. The main requisite is a deep, fertile, and friable soil, with good drainage and free from stones. In these requirements they are in complete accord with the vegetable garden. The ground selected should not be exposed to the sweep of winds, whereby the moisture will be quickly evaporated, nor where the snow will be blown off. Protection from evaporation — evaporation is always increased by winds — and preserving the snow covering that Nature generally puts on the ground in winter are highly essential. The latter is more important than may at first appear. It is fully realized by farmers that a covering of snow on winter wheat or newly seeded meadow is a great protection against the roots being thrown out by the alternate freezing and thawing which occurs when the ground is bare in winter, and the same liability to be thrown out under similar conditions exists with little trees in the nursery. When Nature plants tree seeds she protects the infant plants in winter by the shade of larger trees or with a covering of dead weeds, grass, or fallen leaves.

A slight inclination of the surface is very desirable, for if it is perfectly level, and there should more water fall at any time than can be readily absorbed by the ground, the plants may be greatly injured or killed outright by being submerged. A slight descent facilitates underdraining, which will be necessary if not naturally provided for by a loose subsoil free from water. If the subsoil is a compact clay, and practically impervious to water, underdraining should be resorted to, but such a location should be avoided if possible.

Preparation of the Ground. The selection of the site having been determined upon, the preparation of the ground naturally follows. If the plot chosen is fairly fertile it would best be ploughed or spaded late in the fall to a depth of ten or twelve inches — preferably the latter. This work should be delayed to as late a period as possible so as to expose to the frosts of winter all larvæ or other pests that burrow in the soil. If the soil is not fertile a suitable coat of muck,¹ compost, or well-rotted barnyard manure should be applied and ploughed or spaded under. The latter must be well covered, for if not put below the surface a crop of weeds will very likely spring up the next summer and cause much trouble and expense in getting rid of them. If the condition of the soil at the time of spading or ploughing will permit it the plot should at once be laid out into beds four and one half feet wide and as long as may be deemed advisable. Most of the beds must be covered with lath screens the first year, and a screen six feet long is one of convenient length for handling, and any multiple of that may be adopted for the length of the bed. If the ground is much descending the beds should be laid out closely approaching contour lines; that is, they should be nearly level, but still descending lengthwise enough to prevent water standing in the paths between them. The paths between the beds may be from one and one half to two or more feet wide — two feet being generally deemed ample. The depths of the paths must be regulated by the character of the soil. If loose or sandy they need not be over three inches deep, or four at farthest, but if the soil is close and compact they should be deeper. The soil from the paths can be thrown on the beds, and the entire surface should be made as rough as possible and left in that condition so that freezing can pulverize it, for that is essential.

¹ Muck obtained from a swamp or any wet location should have its natural acidity corrected with lime before its use is attempted. After thoroughly mingling the lime and muck the mass should be allowed to remain in the open air for several months and be occasionally worked over. It can then be composted with barnyard manure and used to good advantage in the nursery.

As soon as the ground becomes dry enough in the spring the beds should be spaded or otherwise worked to a depth of a few inches, but not deep enough to bring to the surface any manure filled with weed seeds that may have been applied in the fall. All stones and sticks must be removed and any lumps of manure, sods, or compact soil should be thoroughly pulverized or raked off. A small-tined potato hook or a long-toothed garden rake can be used for this purpose. The surface of the bed must be finely pulverized and smoothed and the centre made an inch, or a trifle more, higher than the edges—just enough to carry off the surplus water that may fall in time of excessive rains.

For proof of the advisability of ploughing or spading in the late fall and not in the spring, it may be stated that many farmers follow fall ploughing for sowing oats, barley, and spring wheat, and with good results, only harrowing or lightly cultivating the surface before sowing. Of course this system applies only to those portions of the country where the frost goes down from six to ten or more inches in depth. The object is to take advantage of the friable condition of the soil which is brought about by freezing, and the additional advantage of early sowing. This latter is of more importance than it at first may appear. In early spring the soil is invariably moist at the bottom,—and yet it may be dry enough on the very surface to sow seeds in,—and if not ploughed or spaded will retain that moisture for some time, thus aiding in early germination. Instances can be given where early sowing of tree seeds was eminently successful, while those sown ten days later in an adjacent bed resulted in almost complete failure. There is no doubt but that fall planting of the seeds of many of our timber trees would be best were the seeds not liable to be destroyed by birds, mice, or squirrels. It is the natural method. Nature sows nearly all the seeds which she brings forth as soon as they are ripe. Spring ploughing or spading must be resorted to if that work has not been done late in the fall or frost has not pulverized

the ground; but unless the ground lies undisturbed until it is well dried out to the depth that it is to be cultivated, wet lumps will be brought up and these will not pulverize readily, and when they dry out they will bake and leave the ground in a very unsatisfactory condition for seed-sowing. To wait until the ground is dry enough to spade or plough will, unless it is sandy, ordinarily so delay planting that success will be doubtful.

If the ground selected is full of weed seeds it will generally be found profitable, in the end, to delay planting for a year in order to get rid, as much as possible, of the weeds that will spring up from them if not destroyed, for keeping down the weeds is among the most expensive items in nursery work. With such a condition of the soil the ground ought to be ploughed early in the spring and as soon as the weeds show should be gone over with a harrow, cultivator, or heavy rake, this operation to be repeated as often as the weeds show green on the surface. This frequent cultivation will bring a large number of the weed seeds where they will germinate, and frequent cultivation will kill them. If the ground could be ploughed once or twice in the summer all the better. Weeds can be destroyed much cheaper in this way than by pulling them out by hand from among the little plants. If sod ground be chosen it, too, should be ploughed in early spring, frequently harrowed in summer, and about the first of September cross-ploughed and, late in the fall, spaded and made into beds. If not fertile a coat of manure should be applied before spring ploughing. It may seem a waste of time and a loss of the use of the ground to let it apparently lie idle for a year, but it will pay in the end.

Sowing the Seed. When the seed-beds are prepared the forest nurseryman must decide which one of two systems he will adopt in sowing the seeds. In making the selection he must be governed by the condition of the soil in which the seeds are to be placed and the species of trees to be grown. These systems are known as Broadcast Sowing

and Drill Sowing (sowing in rows). Nearly all the coniferous and some of the broadleaf seeds can be sown broadcast, and all species can be sown in drills. The moist weed seeds lying in the ground will invariably germinate sooner than the dry tree seeds, and the weeds, being much more rapid growers than the trees, will, if present in large numbers, suppress the seedling trees unless the weeds are promptly removed on their appearance. Neither weeding with any implement nor cultivation of the surface can be engaged in if broadcast sowing is adopted, but drill sowing will permit this to be done between the rows with small hoes or hand weeders. It also permits cultivation, which at times is very important.

Broadcast Sowing. The reasons which govern in adopting broadcast sowing are: Greater yield on the same area, doing away with the labor of weeding and cultivation, and a more vigorous growth of seedlings. The first two reasons named need not be questioned if the ground is free from weed seeds, and the last one appears to be based on fact, but it is difficult to show why it is so. It is probable, however, that the more complete shading of the ground afforded by the crowns of the seedlings, when standing close together, prevents evaporation and provides a condition somewhat like that of the forest floor under older trees. Aside from the claim that a more vigorous growth of seedlings results from broadcast sowing, the fact that a greater yield from a given area can be secured by this system should receive favorable consideration; and especially so if the ground is not seriously filled with weed seeds. If it is so filled the cost for labor in removing the weeds, and the consequent injury to the little seedlings by such removal—for they will doubtless stand so close that pulling up the weeds will destroy more or less of the seedlings—will more than counterbalance the increased yield and any real or fancied vigor of growth. If weeds are allowed to grow in a dense stand of seedlings they will not only rob the soil of its food and moisture, but overtop and suppress the

diminutive seedlings. Whether or not broadcast sowing in the seed-beds should be adopted must mainly depend upon the amount of weed seeds in the soil.¹

When the seed-bed has been properly prepared the seed should, in some manner, be evenly scattered over it without delay. This is a somewhat difficult task and it must be done by hand, for no machine has yet been brought out that will broadcast seed evenly on so narrow a strip of ground without scattering more or less of it where it will be wasted. The seed would best be thoroughly mixed with several times its bulk of light-colored sand and then scattered as evenly as possible. Enough sand should be added to go over the bed at least twice. The color of the sand will indicate where the seed has fallen. Small seeds can, when mixed with sand, be quite evenly sown with a sieve with suitable meshes.

As soon as sown the seeds should be pressed into the ground with a bat, hoe, or shovel, or a board can be laid on and a light blow given it. After the seeds have been pressed into the ground a coat of finely pulverized loose soil or, better, a mixture of well decayed leaf mould and sand, must be evenly sifted over the entire surface to a depth of from three sixteenths to one fourth of an inch, — this applies to all conifers; and if this covering is of loose material it should be slightly pressed down, but if it is of such a character that it will crust after being wet, it should not be.

The amount of seed to be sown on any given area must depend largely upon its percentage of fertility, a point which can and should be determined before sowing. About one sixth of an ounce of White Pine seed is deemed a suitable allowance for one square foot of bed on the basis of sixty per cent fertility. This amount should produce two

¹ If the ground is at all dry the seed-beds should be thoroughly watered a day or so before the seeds are sown, and when in a suitable condition the surface should be gone over with a rake, care being taken not to disturb the surface when it is wet enough to bake.

hundred plants, which are as many as can be safely grown on one square foot, although a greater number has been frequently produced; but only in extremely fertile soils and under favorable conditions can so great a number be grown. Probably seed for one hundred and fifty plants to the square foot would be better. Of course smaller seeds will require less weight proportionally. A table showing the number of seeds to the pound of the important species of timber trees will be found in the Appendix, and computation can be made suitable for each one.

Sowing in Drills. The seed-bed should be as carefully or better prepared for sowing in drills than in the case of broadcast sowing, for any lumps near the surface will greatly interfere with satisfactory work, and especially so if the seeds are to be sown with a seed drill, as then the covering must be that of which the surface of the bed is composed. If sowing by hand be practiced, a marking-board as wide as the rows are to be apart, and long enough to reach across the bed, must be provided. For conifers strips three eighths of an inch thick, with one edge V-shaped, should be nailed on each edge, the V-edge to project three eighths of an inch below the surface of the board. The other edge can be flush with the top of the board. A handle similar to an old-fashioned door-handle can be fastened on the top of the marker, and if the board is light one person can readily operate it.

To mark for the rows place the marking-board squarely across the bed, with the V-projections downward, and press it down with a slight movement endwise, so as to make grooves the full depth of the projecting V's. A pole with the distance the rows are to be apart plainly marked on it can be laid alongside of the bed as a guide, or the following projection on the marker can be placed in the forward groove and thus even spacing of the rows be made easy. As absolute accuracy is not essential, any convenient method of spacing may be adopted. The seeds can now be dropped in the grooves and spaced in them as evenly as possible,

after which they should be covered even with the surface of the bed with fine loose soil, or, as recommended for broadcast sowing, leaf mould and sand. Coniferous seeds should be placed from one fourth to three fourths of an inch apart in the rows, the distance being governed by the percentage of fertility and the species. After the seeds are covered a board can be laid on and a light blow with a spade be given; or the operator can step on it, if the covering of the seeds is of loose material; if not, then nothing need be done with it.

When broadleaf seeds are to be sown, the width of the marker and the thickness and depth of the V-shaped strips must be greater. Rows eight inches apart, with a thickness and depth of one half inch for the V's will serve well for nearly all broadleaf trees except the nut-bearing ones—directions for these being given elsewhere (page 117) when considering tap-rooted species. Elm seeds and a few others can be sown the same depth as conifers. Nearly all broadleaf seeds should be spaced from one to one and one half inches apart in the rows, if there is sixty per cent fertility. This is on the supposition that they are to be removed from the seed-bed at the end of the first year, or the second year at the latest. If allowed to remain longer, they should be placed farther apart in rows.

The method for sowing in rows thus far indicated is suitable for small areas, but when large ones are to be sown it is advisable to use a seed drill for such seeds as it is fitted for. A well-devised one,—and there are such,—when properly adjusted and operated, will not only save much time and labor, but will sow more evenly than can be done by hand, although it has some drawbacks, one of which is the difficulty experienced in running it across the beds. That can be successfully done, but it takes more time than to run it lengthwise and there is danger of breaks in the seeding. The only advantage in running it across the beds lies in convenience in cultivating the plants; but when beds are not over four and one half feet wide and the rows are length-



PENNSYLVANIA STATE FOREST NURSERY, ASAPH, PENNSYLVANIA

Showing lath screens over seedlings. — *Photographed by N. A. Caulkins.*



WHITE ASH

In the experiment forest plantation at the State University, Champaign
County, Illinois. — *Courtesy of U. S. Forest Service.*

wise, there is little difficulty experienced in reaching half-way across to destroy the weeds or cultivate between the rows. Another objection to the use of a seed drill is that the seeds are necessarily covered with the soil which forms the surface of the bed, and unless that is loose and friable it is liable to crust and prevent the tender and weak plants from breaking through it.

If the beds are four and one half feet wide and the rows run lengthwise and are six inches apart, then eight rows can be placed on a bed with a six-inch border next the paths. This border is desirable for the reason that if close to the edge the plants will suffer for water in summer and be frozen out in winter. A wide board can be used for a guide and the operator can walk on it. The drill not only sows the seed uniformly but covers it, thus completing the work at once. Crusting of the surface can be avoided by giving the bed a coating that will not crust.

Screens. The seeds being sown, they must be protected from destruction by birds, germination must be aided, and the tender seedlings shielded from the burning sun. All these ends can be attained by using screens made of common wood laths used by plasterers. Procure two strips of light, strong, straight-grained lumber, — preferably pine, — one inch thick, two inches wide, and six feet long. Upon these strips nail the laths crosswise, placing the laths as far apart as they are wide. This will cause one half of the light to be shut off. The laths should project four inches at each end beyond the strips to which they are nailed, and two nails should be placed in both ends of every other lath to keep the screen in proper form.

To hold the screens in place, stakes must be driven along the edges of the beds, four feet apart across and six feet apart lengthwise. These stakes must be driven into the ground deep enough to be firm — they are usually about three feet long — and must also project above the surface from eighteen to twenty inches. Near the top, and on the side next to the plants, pieces an inch thick, about two inches

wide, and six or eight inches long should be nailed horizontally to the stakes, on which the screens can rest when used for shading. In nailing on these pieces, place those on one side of the bed two inches lower than on the other, so as to give a slight slope to the screens. This will cause some of the rain falling on them to be carried off when there is a heavy downpour. While the principal use of the screens is to shade the plants, they can be used for other purposes as will be seen.

Protecting the Seeds from Birds. There are sections of the country where birds commit serious depredations on the seed-beds and some method must be adopted to prevent them. A recent practice is to coat the seeds with red lead, which the birds possibly (?) recognize as a poison. The seeds should be moistened and enough dry lead added and thoroughly mixed to give a fair color. The lead does not appear to in any way affect germination. While not expensive the system requires some labor and care, for the lead and seeds must be well mingled and the latter dried before they can be sown with a drill. It will not protect from mice and squirrels, nor always from birds. Full and complete protection can be secured if the screens already described are used to aid germination.

Aiding Germination. Germination is best secured by a continued moist condition of the soil in the seed-bed. Without moisture germination will not take place, and if once begun and then arrested, through evaporation, the seed's vitality is either generally impaired or entirely destroyed. There is generally an abundance of moisture in the soil in the spring of the year, and if moderate rains are frequent, nothing need be done to retain it; but there is sometimes a dry period at that time, and, if so, the germination of seeds with hard shells is greatly delayed, and partial or complete failure may ensue.

The most satisfactory known method of controlling the moisture of the seed-bed is to place the lath screens, already described, over the beds, elevated only one or two inches

above the surface, and if necessary cover the open spaces with loose laths. The loose laths can be removed from time to time as germination progresses or conditions demand, so that by the time the plants begin to show aboveground only one half of the sunlight is shut off, and the screens should then be shifted. If the soil continues moist, no screens are necessary to aid germination, and none would be needed near the surface unless to protect from the birds, but if put on at any time they should be removed as soon as the plants begin to break through the surface. This method protects the seed-beds from drying winds and bright sunlight until germination takes place, and until the roots of the plants can obtain moisture from the soil. Also, it shields the seeds from the light in the beginning — a consideration which seems to be quite important, although the reason appears to be somewhat obscure — and protects them from birds.

Protecting from Bright Sunlight. As soon as coniferous seedlings begin to show aboveground the screens should be placed on the blocks that have been nailed to the stakes, in which position they will protect the young plants from the burning rays of the sun. Broadleaf trees do not, as a rule, require shading. Judgment must be exercised in handling the screens, for no specific rules can govern all conditions which changing atmospheric phenomena may bring about. There is no need for them on a cloudy day, or when it rains, unless an exceptionally heavy fall occurs, when they will serve to carry off a part of it. It is advisable to remove them during warm, cloudy, and moderately wet weather to avoid disease. They must also be removed to permit weeding, cultivation, and, in most cases, watering. There is little or no need of them after the first year, and they can be removed by the last of September and carefully stored away for next year's use. The screens provide a partial shade which the tender plants demand, and, to a limited extent, prevent evaporation of moisture from the surface of the beds. The benefits resulting from their use far more than equal the expenditure of time and money.

Care and Cultivation. With the appearance of the plants aboveground diligence in watching their condition must be increased. The little seedlings are weak and tender in their early days and must be cared for. Their roots extend but a little way into the ground, and should the surface for an inch or two in depth become dry the plants will either die from lack of moisture or be checked in growth; therefore provision must be made to supply water in case insufficient rain falls; but what is termed "artificial watering" should not be resorted to unless it is clearly necessary. It is not always advisable to water young plants as soon as the surface of the ground appears dry. Examination should be made to ascertain how near the surface moist soil can be found, and if close at hand, artificial watering should not be undertaken; but if the soil proves to be dry around the roots, then watering becomes necessary; and when it is done there should be enough applied to last several days, for light or intermittent watering may be more disastrous than none at all. A slight sprinkling with a hose or watering-pot will soon dry out and leave the ground crusted and baked, with cracks occurring in the surface through which evaporation takes place rapidly. The necessity for thorough watering when once begun cannot be too strongly insisted upon. The ground should be wet down as far as the roots extend at the very least, — deeper would be better, — and kept in that condition until rain comes to their relief. Water should be applied slowly, giving time for it to soak into the ground. In large nurseries an ample supply should be provided and led in pipes, with hydrants attached, so as to reach the entire field, where it can be thrown on the beds from a hose with a spray nozzle. If a small area only is planted a watering-pot can be used, but if the ground is to be successively devoted to growing tree plants such a makeshift will not prove satisfactory.

Surface irrigation of seed-beds in forest nurseries, as is practiced on farms in arid regions, has been tried in several instances with varying success. Its adoption must be

determined by conditions. Sub-irrigation — carrying water in porous or perforated pipes eight or ten inches below the surface — has succeeded well in greenhouses and possibly might be adopted in forest nurseries. Experiments in that direction should be undertaken, for that system puts the water just where needed and does not cause cracking of the surface.

No matter how carefully watering with a hose or a pot may be done, there is invariably formed a muddy, compact surface of the soil, and this is followed by crusting and cracking of the surface as soon as the sun shines upon it for a few hours, or a strong wind blows over it. After every such occurrence, and also after every heavy rainfall, the crust which forms should, where the system of sowing will permit, be broken and the surface pulverized as soon as the ground is dry enough to work. By doing this less water will be required, for however strange it may appear, fining and pulverizing the surface soil actually retards evaporation. This fact is well understood by those who have tried it. It is so thoroughly known by farmers over a vast area in the so-called semi-arid sections of the Great West, where there is but slight rainfall, that profitable crops are being grown though not a drop of water comes to the ground after the seeds are sown—success being achieved by ploughing deep just before the rainy season, and this followed by a frequent stirring of the surface of the soil where the character of the crop will permit it. A blanket of dust, however dry it may be, prevents rapid evaporation.

Stirring and making fine the surface of the soil not only lessens evaporation, but it admits air to the roots, which is necessary, and, in addition, it keeps down weeds and lessens the labor of removing them by hand. Clean cultivation is as important in the forest nursery as elsewhere, and it cannot be begun too early; and that means stirring the soil whenever it can be safely done. Stirring the soil to a slight depth, but not too close to the plants, can be pro-

fitably kept up until late summer. Manifestly this does not apply to broadcast sowing, as no cultivation can take place there. Only hand-weeding can there be indulged in.

Damping-off. During the first few months of the life of the plants they are subject to a fungus disease known as "damping-off." They may look all right at night and the next morning be wilted or covered with a thin spider-web-like film, and their death-knell has been sounded. They will soon die. It is quite common in greenhouses and is there known as "the Fungus of the Cutting-Bench." There is no known remedy for a plant that has been attacked, and unless at once arrested the disease will rapidly spread to all adjacent plants. Removal of all infected plants, and the soil in which they stand, and giving the remainder of the ground a coat of dry hot sand has been the remedy usually adopted to stop its spread. It is stated in the public prints that in Germany spraying with the well-known Bordeaux mixture has shown excellent results in preventing an attack. As this mixture is known to prevent fungus diseases on vegetables and fruits, and is harmless, inexpensive, and easily applied, it would be well to give it a thorough trial. Damping-off is more prevalent among conifers than among broadleaf trees, although Maple and Beech are frequently affected. It is apparently induced by excessive moisture in the soil, accompanied by damp, warm weather and absence of sunshine. Thick sowing also appears to have something to do with inviting attacks. Good drainage and removal of the screens on cloudy days, together with providing ample room for the plants, would certainly be the logical method of preventing it. Only prevention can cope with it. If one side of the screens is lower than the other, as suggested, and they are left on while it rains, some of the water which falls on them will be carried off, and this may aid.

Protecting Seedlings in Winter. By early autumn all plant growth will have ceased and preparations should be made to protect the shallow-rooted seedlings from being

thrown out of the ground by alternate freezing and thawing during winter and early spring. One method of doing this is to cover the whole bed an inch or two deep with moss and decaying leaves from the forest, being careful not to put too much over the plants. Conifers rarely reach a height of two inches at the end of the first season's growth and a slight covering of their tops will do no harm. Pine needles have served as an excellent covering in many known cases, although it has been claimed by some that they heat and thus destroy the plants; but it is hard to conceive that heating can occur when the covering does not exceed two inches in thickness. Where failure has occurred in the use of pine needles it has undoubtedly been caused by covering too deeply. If the materials named cannot be procured, cut straw will serve a very good purpose, or a covering of coarse manure or barnyard litter placed between the rows and close to the plants will answer better than nothing, although these may be filled with weed and grass seeds. If green hemlock boughs can be obtained and spread several inches thick over the entire bed they will prove a very good protection. A few plants may be broken down but not many. The first snow that falls will be likely to pass down through the boughs, surrounding and covering the plants, and may lie there until spring. The boughs gradually shed their leaves, and by the time danger is passed nothing but the naked branches are left as covering. The leaves will act as a mulch, although they seem to possess little manurial value. The most trying time is during the months of February and March, and the removal of the covering should not take place until alternate freezing and thawing has ceased; but, unfortunately, it is impossible always to determine that time.

Another plan has been adopted at the New York State Forest Nursery at Saranac Inn, and also at the Pennsylvania State Forest Nursery at Mont Alto, which has thus far proved very successful, and, although somewhat expensive, yet it costs but little more than the others and results

appear fully to justify the expense. Nothing is done with the seed-beds until snow occurs, and when two or three inches have fallen, coarse, cheap burlaps are placed over the beds and weights of some sort placed on the edges to prevent winds blowing them off. The snow under the burlaps melts slowly and during some winters may not melt until near spring. Even though the snow under the burlaps should melt early and none fall afterward, they alone furnish a fairly good protection. But if deep snows fall after the burlaps are put on, and remain during the winter, there is great danger that the plants will be smothered and die for want of air, and it may be necessary to remove a part of the snow. It is well known that wheat and grass are frequently killed by being deeply covered with snow for a month or so. Success with any system will depend largely upon the character of the winter. If the surface of the beds can be continually covered until spring with a blanket of snow not to exceed four to six inches in depth, no other covering will be required. It is manifest that climatic conditions modify or entirely do away with the necessity for winter protection. In many sections of the country no protection whatever is needed and in others more or less must be given. A knowledge of the prevailing winter conditions should guide in determining what should be done.

Fertilizers for the Nursery. Trees respond to a generous diet as well as do other growths of the soil, and they require substantially the same kind of food. When a tree is well established its roots run deeper in the ground than ordinary farm crops, and by so doing secure food there which they — except the tap-rooted ones — cannot do in early life when the small roots reach but a little way down; and this fact makes fertility of the surface soil highly essential. If the surface is fertile there is less wandering of the roots after food, and the plants grown in such soil have a more compact and vigorous root system, are stronger, and in every way better able to withstand the shock of removal to the forest.

Undoubtedly the best fertilizer for a forest nursery is decaying vegetable matter, frequently called muck, — really humus, — for in such is the most vigorous tree-growth.¹ But that cannot always be secured in ample quantities — and it should be liberally applied — and something else must be provided. The next best is well-rotted barnyard manure, which, when free from weed seeds, is very difficult to obtain. Still, it can be used, even when containing weed seeds, by ploughing or spading it under deeply and trusting to time to destroy the germinating power of the seeds, something which may take many years.

Failing to secure humus, or barnyard manure, in a satisfactory condition, resort must be had to what are known as artificial fertilizers. Caution should be exercised in choosing these. Before determining which to use, careful experiments should be made to ascertain which is best for the soil to which it is to be applied, for soils are seldom alike. Some artificial fertilizers may serve a good purpose on one soil and be of no benefit whatever on another. There are two, however, which almost invariably fill the demand for forest nursery enrichment, and certainly can do no harm. They are ground bone and unleached wood ashes. The former furnishes phosphoric acid, a small amount of lime, and some nitrogen; and the latter gives the much-needed potash. Fertilizers that are soon exhausted are not advisable. Something is required that will last for two or three years, — until the plants can be removed, — and this feature makes ground bone and wood ashes admirably adapted to nursery conditions.

A liberal application of wood ashes a few days before planting, followed by ground bone, will serve a good purpose in nearly all soils. They should be applied separately for the reason that, if mingled before applying, the potash in the ashes will liberate the nitrogen in the bone meal and it will be lost. Apply the ashes and mingle them with the soil to a depth of about three inches, and two or three days

¹ See footnote to page 90.

thereafter add the ground bone, which need not be so deeply mixed. The seeds can then be sown at once, as contact with the bone meal does not affect their germination or vitality. From ten to fifteen pounds of bone meal and twenty-five pounds of unleached wood ashes to a bed four feet wide and one hundred feet long will be a moderate application. If the bone is not ground very fine its effects will be felt for four or five years, and an application made within three years thereafter can be much lighter.

Kainit is largely used in German forest nurseries in place of wood ashes. It is an impure salt with a large amount of potash in it. Its use in this country has been quite limited and it has not met with unvarying success. Like ashes it should be applied a few days before the seeds are sown, for it is liable to destroy their vitality if in actual contact. Other fertilizers are being experimented with in this country, but not enough is known of the results to justify an opinion of their usefulness. Lime produces good results on some soils but not on all. It is not plant food of itself, but releases some that would be unavailable without its aid. Norway Spruce is said to be injured by it.

Thinning-out. If seeds have been sown thickly the seedlings will necessarily be crowded. This may happen by accident or through a high percentage of germination, and if it has occurred the plants in excess of the proper number should be promptly removed, for a crowded condition not only tends to disease, but the crowded plants will certainly be weak and stunted, should they grow. Nothing is gained but much lost by crowding in the seed-bed or in the transplant nursery.

Removing the Plants. In removing the plants from the seed-beds and from the transplant nursery extreme care should be exercised in taking them up so that their roots will be injured as little as possible. We should remember that roots are a positive necessity to a tree's life, and they should not be destroyed when it can be avoided. There is, naturally, a properly proportioned development of roots

and branches in a tree — a complete equilibrium of parts. In removing a tree from where it is growing some of the roots are unavoidably broken off and the natural balance is destroyed, and increased demand is thus made upon those which remain when the tree is again placed in the ground. With broadleaf trees the balance can be somewhat restored by cutting back the crown, but that cannot be done with conifers intended for timber. No cutting back can take place with these, except where a vagrant limb may have started out in an effort to assume leadership. To cut back the leader practically ruins the tree unless another one can be encouraged, an effort by no means likely to be successful. Therefore but little lessening of the demands upon the remaining roots can be made, and the only thing that can be done to aid the tree in its struggle for life is to save all of the roots possible.

The best way to accomplish this, when removing the plants from the seed-beds and transplant nursery, is to dig a trench eight, ten, or twelve inches deep — the depth to be governed by the depth the roots have penetrated — along a row of plants and a few inches from it. Then thrust a spading-fork, with narrow tines spaced an inch and one half apart, to the full depth of the trench and midway between the row and the one next back of it, and gently raise the plants out, carefully breaking the soil so as to liberate the roots with as little injury as possible. Seizing the plants by their tops and pulling them out should not be tolerated; but, instead, the ground should be broken and carefully shaken from the roots. The removal of one row gives opportunity to treat the one next back of it in the same way. A little experience will demonstrate the value of extreme care.

Root Pruning. It is not denied that pruning the roots of seedlings or transplants may sometimes be advisable. If they have tap-roots, or other roots are so long as to require considerable digging to place them in a natural position, then cutting off the tap-root or the straggling one,

may be the best thing to do — certainly so in the case of the tap-root; but if there is no tap-root, or the roots are reasonably compact, there is no reason for cutting off any unless seriously injured. It is the practice of some to prune uninjured roots more or less when setting out a tree. What the purpose is cannot be imagined. If a person has already suffered severely from loss of blood it would be a hazardous remedy to bleed him still more.

Heeling-in. It is sometimes found advisable to remove plants from the seed-beds or from the transplant nursery before circumstances will permit their being set out in the forest; or it may be advisable to take up seedlings a few days before setting them out in the transplant nursery, in order to make the ground ready for another sowing. In either case they must be so cared for that their roots will not be exposed to the sun, wind, or frost, or in any way become dry. The accepted method of doing this is termed "heeling-in." This is accomplished by digging a trench about as deep as the plants are long, including their roots, with one side inclined about twenty degrees from the perpendicular, and placing the plants against the sloping side and covering the roots and a portion of the tops with fine earth, care being taken to fill all the interstices around the roots. This filling-in is essential, for, if not done, the roots are liable to become dry and injury or death of the plants may ensue. The plants should not be placed too thickly, for if they are, heating and moulding are liable to occur, and this will kill them. When the row of plants has been properly covered with five or six inches of soil, another row can be placed parallel and treated in the same manner. They should not be disturbed until taken out for transplanting into the forest or transplant nursery, when their roots should be at once immersed in thin mud and as soon as possible placed in the ground where they are to grow. If the ground is at all dry at the time of heeling-in, it should be well watered before the plants are placed in it, and not allowed to become dry again before their removal.

Nurserymen sometimes heel-in plants to await shipment. If it is carefully done, and they are not allowed to remain in that condition too long, little injury may occur; but it is by far the best way to let them remain where they grew until the day of shipment arrives. However, it will be better to heel them in than to let them start to grow in the beds before removal. Neither should they be kept long enough in the heeling-in state for growth to begin. The practice of taking plants up in the fall and heeling them in has nothing to justify it. It is true that by so doing they can be kept dormant in the spring and allow greater time to handle and transplant; but that can be accomplished just as well by taking them up in early spring. It is little better than fall planting, which is not deemed good practice. Only cold storage will meet the case.

Removal of the Plants to the Forest. The best method of taking up the plants has already been indicated, but it should here be added that immediately on removal from the ground in the nursery they should be placed in some receptacle and evenly stratified with wet moss and kept carefully covered until set out in the forest or heeled-in. The roots must not be exposed to sunshine, drying air, wind, or frost. They must at all times be kept moist and the least time possible should elapse between removing the plants from the nursery and placing them in the ground where they are to grow.

Setting the Plants in the Forest. Presuming the ground to have been properly spaced, two men and a boy should be in readiness to begin work on the arrival of the plants. One of the men should have an ordinary mattock with which to dig the holes, which he should make large enough and deep enough to give the roots ample room. A few strokes of the mattock will do this, but some earth to mingle with the roots should be made fine by the man using the mattock. The other man should receive a plant from the boy who is carrying a quantity of them in a bucket, where their roots are submerged in thin mud, and

place it in the hole so that when set out it will stand a trifle deeper than in the nursery. Then, as the ground settles around it, the plant will bear practically the same relation to the surface that it did in the nursery. Fine earth should be carefully mingled among and on the roots and firmly pressed down. If there are any long roots which cannot be placed in a natural position without much digging they may be curled around in the excavation. That is better than to cut or break them off. While packing the earth firmly around the roots and plant may seem objectionable, experience shows it to be advisable. The earth should come in actual contact with the roots to secure the best results. If sods have been removed, or decaying leaves can be handily obtained, these should be placed around the plant to act as a mulch. Decaying wood or even stones serve a good purpose in preventing rapid evaporation from around the roots.

Various planting implements have been devised and used, but none have proved so effective and practical as the mattock in the hands of an intelligent and industrious man who will dig the hole large enough and provide fine earth to place among the roots. Any method which compels cramping or packing the roots together is objectionable. Plants thus set out may, and many do, live, but to place the roots in their natural position is by far the best way.

If the plants must be shipped to a distance requiring several days in transmission, some one who has had experience, and is an expert in packing the various species for shipment, should be engaged. Unless the work is understandingly done the plants are liable to injury or death, through heating, moulding, or drying of the roots. Experiment in that line is liable to be very expensive, and written directions can hardly be expected to give the necessary information. In all cases plants should be unpacked and heeled in immediately on arrival at place of destination, unless promptly set out in the forest.

XIV

THE TRANSPLANT NURSERY

A TRANSPLANT NURSERY may be defined as ground into which seedling trees are removed in order that a better root system may be developed prior to placing them in their permanent home — the removal from the seed-bed to the transplant nursery occurring during the first few years of the seedling's life. If trees are allowed to remain long where the seed was sown the chances for successful removal diminish rapidly as the years go by. It is practically impossible to remove any but the very smallest without serious mutilation of their roots, and this mutilation unavoidably happens to the most important part of the root system, the small fibrous portion. It is these fibrous roots that send out the little hairs with microscopic mouths which suck in the moisture and mineral food, and it is these roots that suffer most in removal of the tree from its birthplace. If the tree is removed from the seed-bed when young, its roots have not spread far and their renewal is necessarily close to the stem, and if a second removal occurs within two or three years, the roots will be found so compact that comparatively few of them will be seriously injured. Such being the case the tree will be far better able to withstand the shock of removal to the forest than if it had few such roots, which would be the case had no removal to the transplant nursery occurred. Commercial nurserymen have long acted upon this fact, and they seldom send out either fruit or ornamental trees that have not been transplanted once or oftener — frequently three times.

The necessity for this treatment attaches itself with greater significance to coniferous than to broadleaf trees. If the former are allowed to grow without disturbance of

their roots by transplanting until they reach the age of ten or more years, it is seldom that they will survive a removal. Their roots have penetrated the soil so deeply that the fibrous ones at the ends are unavoidably lost by that operation. This is also true of such broadleaf trees as have tap-roots. Their successful removal is difficult at best, but practically impossible if allowed to grow to ten or more years of age before deprivation of that especial feature. Broadleaf trees that have no tap-roots need not necessarily be removed to the transplant nursery, but may be transferred to the forest when one, two, or three years of age, depending upon the rapidity of growth in early life and the character of the forest ground in which they are to be placed.

In addition to the foregoing it should be realized that the early growth of most conifers, especially White Pine and the Spruces, is very slow. A White Pine is not likely to reach a greater height than twelve inches during its first five years' growth. The sixth year it may grow ten or more inches, and from that time on it may annually add to its height twenty, or even thirty inches, until it reaches the age of forty or fifty years, when its growth begins to lessen. Because of this slow growth in early life it is best to give it a home in the transplant nursery until near the age when vigorous growth begins, in order to guard against the many dangers which would beset it if placed where it could not be cared for.

Probably two years in the seed-bed and two in the transplant grounds will more certainly bring success than a longer or shorter period in either, yet in case of broadcast sowing in the seed-bed it has sometimes been found advisable to remove them to the transplant nursery when one year old, especially if the growth has been vigorous or the plants are crowded; but where drill sowing has been adopted there is less liability of crowding and they may remain there for two years and then be placed in the transplant grounds. If one-year-old seedlings are put in the transplant

nursery it may be best to let them remain there for three years; but this must depend upon their size and vigor, and the character of the forest area into which they are to be transferred. They should be large enough to hold their own there. As a rule White Pine can be removed into the forest when four years old, for it is then about ready to begin a vigorous and rapid growth; yet good results have been achieved by setting three-year-old seedlings in the forest. If not removed to the transplant ground until two years old, two years' sojourn therein should be sufficient.

Under favorable conditions of forest area to which the plants are to be removed it may be advisable to let the seedlings remain undisturbed in the seed-beds until three years old and then remove them directly to the forest. Of course this would be the most economical method, if successful, which it sometimes is when there is an ample rainfall for the first year, and rank vegetable growth does not rob them of light, food, and moisture. That this plan succeeds in many cases is true, but the chances are somewhat against it.

The transplant nursery is a simple affair. It should be near the seed-beds to save time, labor, and exposure of roots. Fertilization and preparation should be the same as for seed-sowing. Beds may be prepared or the ground left level with frequent paths constructed for convenience or to carry off surplus rainfall. The plants can be set in rows of any convenient length. For conifers the rows may be from six to eight inches apart and the plants from three to four inches apart in the rows. Both of these dimensions may be changed for economy of ground, but care should be taken not to crowd the plants so that they will suffer for either food or moisture. For broadleaf plants the rows should be a few inches farther apart and the distance between them in the rows a little more than for conifers. To facilitate planting a furrow should be made just deep enough to let the roots rest on the bottom so that when they are covered the plants will be a trifle deeper in the ground

than when they stood in the seed-bed. They should be carefully placed in the furrows and fine soil put over their roots and well packed around them. Compacting the soil around the roots is very essential, for without it failure is likely to occur, even though rains should follow or watering be resorted to. The soil should everywhere come in contact with the roots.

When the plants are taken from the seed-beds their roots should be carefully protected and no delay be allowed between their removal and replacement in the ground. A few minutes of hot sunshine, strong wind, or frost at this time may be fatal. Cultivation of the transplant nursery, by keeping down the weeds and loosening the surface of the soil, adds to the vigor and growth of the plants the same as with farm and garden crops and should be no more neglected in one than in the other.

Notwithstanding that full instructions for growing plants have thus been given,—and success can be achieved by following them,—any one desiring to plant but a few hundred, or even a few thousand, will probably find it to his advantage to purchase the stock instead of growing it; largely for the reason that by so doing he will save at least three years' time. In some of the states the residents thereof can now secure plants of the state's forestry department at actual cost of production, and printed instructions for planting them will be furnished; or, if requested, an expert will be sent to direct the work, the applicant for such service defraying only traveling and other like expenses. At least this is true of New York and Pennsylvania, and should be of all other states. In fact the state can well afford to furnish plants gratis to all who will plant and obligate themselves to care for them properly. Many of the states are furnishing fish-fry free of all charges to place in the streams of the state, and certainly trees are of enough importance to be placed on a parity with fish.

XV

HOW TO CARE FOR AND WHEN TO SOW FOREST TREE SEEDS

NATURE takes little care of the seeds of our important timber trees. She practically sows them as soon as they mature and fall from the tree, and their destination is little or no better than chance. In so far as the period of sowing is concerned, we may, with few exceptions, follow her ; but this is not always convenient nor is it in all cases advisable. Some tree seeds can be safely and advantageously stored for a time and the sowing delayed. This can be done with nearly all seeds that mature in the latter part of summer or in the fall, for with these Nature does not demand immediate growth. But of such as ripen in early summer, as do the Elms and soft Maples, she demands prompt growth, and such cannot be stored, but must be promptly sown that they may at once begin life and become strong enough to endure the rigors of the coming winter. Such seeds cannot, after becoming ripe, be kept many days without seriously impairing their vitality ; but practically all seeds ripening in the fall can, with the right care, be stored until the following spring, and some for a longer time, even for three years ; but it is not advisable to use seed of any species that is more than one year old, and it is far better to sow them the spring following their maturity.¹

¹ The germinating power of seeds is not uniform, even when they are gathered from the same tree, at the same time, and receive the same treatment in the seed-bed ; and those germinating soonest produce the strongest plants. Germination of coniferous seeds may be aided by soaking them twenty-four hours in water at about 130° F., but soaked seeds should not be sown in dry ground unless the ground is immediately watered in some way, for otherwise the dry soil will absorb the moisture in the seeds and the further progress of germination, which is then undoubtedly in an incipient stage, will be fatally arrested. .

Seeds ripening at the close of the growing season may be divided into three classes: (1) Those that can be dried without impairing their vitality; (2) those that can submit to partial drying without very seriously affecting their vitality, although even partial drying will injure them more or less; and (3) those that are seriously and, with some species, fatally injured by becoming at all dry. In the first class can be placed the Pines, Spruces, Firs, Balsams, Larches, Hemlocks, Catalpas, Sycamore, Locusts, and Birches. These may all be dried without injury if kept in a cool place where the atmosphere is in a normal condition of humidity, and they will suffer little or no deterioration for a few months, but a warm dry atmosphere may do great damage. While Nature sows all these in the fall, it cannot be truthfully said that a delay until spring in sowing is injurious, for this delay and moderate drying seems to be beneficial with some species in fully perfecting the ripening process. Nor can it be said that the artificial care of these seeds by properly storing them is not better than to let them lie on the ground exposed to such conditions of weather as may naturally come, for should there be much wet and comparatively warm weather in the late fall and early spring the seeds might begin germination. Should this occur, as it sometimes does, they would be destroyed by freezing, or decay from excessive moisture, and as these conditions are not determinable it is found that spring sowing is more frequently successful.

In the second class are those which can endure some drying without very serious consequences, but with these drying is not at all necessary and germination is better without it. These are the Ashes, Yellow Poplar, Cucumber, Sugar Maple, and Basswood. The seeds of these may be stored in a dry cool place, the same as the first class, but their vitality is much impaired by that process, and if germination takes place it will be slow and may be delayed for a year or more. All of this class of seeds have a quite hard shell, somewhat impervious to moisture, and instead of being liable to in-

jury in consequence of being kept moist they are actually benefited by it. Repeated experiments show that fall planting of all these is preferable, and that germination is then far greater than if they are allowed to become dry. As few or none of these are liable to be destroyed by squirrels, mice, or other animals, there is no inherent reason why prompt sowing may not be followed. Only convenience, or other extraneous reason, should prevent it. In such a case, however, the seeds may be stratified in a box with moist sand — a layer of sand an inch or so in thickness and a layer of seeds from one to two inches thick according to size of seeds, alternating as the box is filled — and placed where they will not dry out nor be warm enough to induce germination or decay. If the box is placed in the ground and slightly covered with earth, but protected from water finding its way into it, the seeds will keep all right, as freezing will not injure them, but, on the other hand, will be beneficial.

The third class consists of the Hickories, Black Walnut, Butternut, Beech, Cherry, Chestnut, and the Oaks. None of these should be permitted to become at all dry. All should be planted as soon as ripe, or at once stratified as indicated for the second class, and they should be placed where they will be subjected to as much freezing as they would be if lying on the ground in the woods. It is not necessary to remove the husk from the walnuts and butternuts, or the pulp from the cherries, if planting is to be done as soon as the seeds are ripe, although with the walnuts and butternuts this, if desirable, may be done without injury in order to reduce bulk; and with the cherries in order to permit sowing them with a seed drill. The husk of the hickory nuts would best be removed, if Nature has not already done it with these as she does with the chestnuts and beechnuts. All these would best be planted as soon as possible after they fall from the tree, if there is no danger that squirrels and other nut-eating animals will destroy them, although it is claimed on very good authority that fall

planting of White Oak is not as successful as when the acorns have been properly stored and the sowing done in early spring. All seeds stratified in moist sand should be sown as soon in the spring as conditions and soil will permit, for Nature has, by this time, begun her work of germination, and delay is then dangerous; nor should the seeds then be permitted to become at all dry. They should not be taken out of the sand until everything is in readiness for sowing and they should then be at once placed in the ground. If sown as soon as they fall not all tree seeds will germinate in the spring next following. They largely do so, but some from the same tree may require another year. There is evidently a sort of ripening then going on for a time before the germ is ready to burst into life, and this ripening appears to be hastened when seeds are stratified in moist sand, and that feature should be recognized.

XVI

TAP-ROOT

A TAP-ROOT is defined by Webster as "the root of a plant which penetrates the earth directly downward to a considerable depth without dividing." Nearly all species of trees develop a tap-root in early life — some in a modest way, others in a very positive form. The roots seek food and moisture and at once penetrate the earth in search of them. The demand for food and moisture is soon satisfied in some species through throwing out lateral roots, and when this occurs the one tending downward ceases to be a dominant feature. Such trees are designated as "shallow-rooted." In others the tap-root is persistent to a greater or less degree all through life, although lateral roots are developed, and such trees are known as "tap-rooted." There are a number of broadleaf trees that belong to the tap-root class, comprising about all whose seeds are inclosed in a hard shell, as the Oaks, Hickories, Walnuts, Cherries, and Chestnut, while some of the Pines, notably the Longleaf, have a very pronounced tap-root.

There are a few species, notably Cherry and Ash, that will suffer the destruction of this feature of their root system without serious results, but for that operation to be successful it should take place when the tree is young — best at one year old, or two years at latest. This can be done by removing the plant from the seed-bed to the transplant nursery, there to remain until lateral roots are developed, when it can be transferred to the forest.

Various devices have been tried to prevent the seedling from sending its tap-root downward so far as to make removal of the plant difficult. One of these is to place boards, stones, or brick six or eight inches below the surface and

directly underneath the seed to arrest the downward course of the root. Another is to use an implement similar to that employed by nurserymen when taking up fruit trees, which consists of a horizontal knife run several inches below the surface and severing the tap-root, the depth of the knife varying with the character of the root system of the tree. The seedlings can then be allowed to remain another year and throw out lateral roots, and thus avoid the necessity of removal to the transplant nursery; but none have proved successful except at too great cost. Under favorable conditions, and with the greatest care, except in the case of the species noted, successfully growing tap-rooted trees and establishing them in the forest rarely occurs. Some practically refuse to grow at all, and but few of them will grow vigorously for several years after removal into the forest, and even in such cases there is much time lost at the very best. The only valid reason for adhering to the practice, even with the least stubborn ones, is to get the plant far enough advanced to withstand the encroachment of such companions as may surround it in early life in its forest home, and it is very doubtful if anything is gained in the end. As this peculiarity of root growth will be noted when considering the several species of our important timber trees, and suggestions made regarding the proper treatment when endeavoring to cultivate such species as possess them, further reference to it here is unnecessary.

XVII

WHEN TO PLANT TREES IN THE FOREST

THE time in which to plant trees is somewhat limited and its selection necessarily largely depends upon convenience and conditions. It must take place in the fall or early spring, because trees cannot be safely removed during the growing season, which occurs during spring and summer, and it is impracticable to plant them in the winter when the ground is frozen. Planting in the fall can be successfully accomplished with many species, — especially with the deciduous ones, — but unless it is properly and carefully done it will not be as successful as spring planting. The coniferous evergreens — the Pines, Spruces, Firs, and the like — evaporate water from their leaves during winter and thus make a greater demand upon the mutilated roots for moisture than do the deciduous ones, and for that reason fall planting of evergreens is not as successful as with deciduous species. But if care is taken to place fine earth in close contact with all roots, leaving no open spaces, and the tree is placed a little deeper in the ground than it originally stood, in order to counteract the tendency to be thrown out by the frost, and the work is done early enough for the ground to become settled and firm before winter sets in, then fall planting of both evergreens and deciduous trees, with chances in favor of the latter, will usually succeed.

It is true that during the winter some effort is likely to be put forth by the transplanted tree towards repairing the injury that has been done to the roots when removed from the nursery, providing the ground is not frozen too hard; but the great danger is that vacant spaces are left around the roots, and if so those exposed will be killed and

the chances of the tree's living will be greatly lessened. It is a well-known fact that when in close contact with the soil roots of trees may be frozen very hard without injury if their relative positions are not changed until both are thawed out. But it is at all times necessary to protect roots from injury which will come to them when naked and exposed to the frost. In spring planting this danger is mainly avoided, and can be entirely so if care is taken to protect the roots from frost when the trees are removed from the nursery to the forest, as it is seldom or never that the ground freezes deep enough after spring planting has taken place to injure the roots, if vacant spaces have been carelessly left, a condition which should not be tolerated. All in all, spring planting is preferable, but conditions may make it necessary to plant in the fall and run the risk of success.

It is claimed that coniferous evergreens, such as the Pines and Spruces, can be safely transplanted in the latter part of August. That will depend entirely upon the condition of the year's growth. If the growth is completed, then the removal at that time can safely take place. In that case the roots will have an opportunity to do something towards repairing damages done them, but unless the growth has practically ceased success cannot follow that procedure.

XVIII

SPACING THE TREES IN THE FOREST

IN order to secure an even stand with all the ground covered to the best advantage, whereby it will produce the greatest possible yield, the trees should be planted equidistant, thus giving each tree its due share of moisture, food, and light. As there must be a large part of the planted stand removed from time to time in order to allow the best development of the trees which are to compose the mature forest, the spacing should be such that each one will, as far as practicable, at all times be left its share of ground. Absolute accuracy is not essential, nor can it always be secured except at unnecessary expense, as local conditions may make it difficult; but where conditions will permit it should be approximately reached. If practicable the most satisfactory spacing is reached by the quincunx form; that is, to set the trees in each row opposite the spaces in the adjacent rows; but there is little ground which should be devoted to tree-planting where there are not obstacles of some sort which will prevent the adoption of this or any exact method. Where it is practicable lines may be set out in some way and the trees placed in regular rows opposite each other, or those in one row opposite the space in the adjoining row, so that each will be given its proper proportion of space, and probably the result will be nearly as well one way as the other. In many places the distance the trees are to be placed apart can, for all practicable purposes, be arrived at by stepping. With a little practice and care a man can soon accustom himself to step any short distance accurately enough to plant trees in the forest, where a few inches, one way or the other, will not matter; while on stony, stumpy, or rough ground he must select

the best places for the trees, even at the sacrifice of even spacing.

Conditions may be such that spacing should not be alike over a given area. If the ground where the trees are to be planted is uniformly fertile, then the spacing should be as nearly uniform as is practically possible, but if any portion is less fertile than the rest, then the trees on that portion should be set closer than elsewhere; for it will there take longer time to secure the desired protection of the surface of the ground — the coveted forest floor — owing to the slower growth of the trees; therefore closer planting is necessary.

Thinning. Notwithstanding that even spacing is desirable, and may be practically accomplished at first, it will be impossible to maintain it during the whole life of the plantation, for no system of distances can be adopted that will allow proper and timely thinning and leave the trees equidistant all the time. There will have to be a compromise at some of the thinnings. Good sense and judgment must direct in all cases. Thinning becomes necessary when the annual growth indicates the need of it, and it should at no time be done further than to give relief from overcrowding; but there must be crowding enough to compel all the trees to drop their lower limbs. No rule can be laid down for the time to begin it, or how far it should be carried on, or how frequently it should be undertaken. Something may be said in a general way, but beyond that only good judgment and a knowledge of the laws governing tree-growth can bring the best results. It is manifest that defective trees should generally be removed in preference to vigorous ones, but in the absence of better ones they may serve as "nurse trees," and if so should be retained while useful for that purpose. It may be necessary to begin thinning in ten or fifteen years from the time of planting, or even earlier with some, if closely planted; or if far apart, not under twenty years, or even longer. The author has in mind a case where White Pine had been planted

three feet apart, and at ten years from setting sorely needed thinning ; while on the same estate others had been set sixteen feet apart, and at twenty years most of their lower limbs were still alive, and thinning would do little good, in fact would be detrimental. Then, some species require less thinning than others at a given date from planting, and only from a knowledge of actual conditions and an inspection of the premises can any definite conclusion be drawn. When one is familiar with the life-history of a tree and the laws which govern tree-growth there is little danger of going astray.

XIX

WILL PLANTING FORESTS EVER BECOME PROFITABLE ?

IT matters little what facts may be set forth or what arguments may be adduced to show the necessity for planting forests, nor does it signify how strong appeals may be made to patriotic and altruistic sentiment, tree-planting in this country will not be engaged in to any great extent unless it can be put on a paying basis and become a profitable, self-sustaining enterprise. The feature uppermost in the mind of any one who contemplates engaging in it is, Will it pay? Can any one afford to invest money and give time and labor to growing trees for economic purposes? However anxious one may be to see our forests restored, or however advantageous it may be to the country at large to have it done, a candid, truthful answer must be that, in and of itself, and based wholly on financial considerations, it will not pay if the present price for labor and the present rates of interest and taxes are to be maintained, and no higher prices for forest products are to prevail when the trees are fit to harvest.

There are certain fixed charges which must go with tree-planting from the day the seeds are sown until the trees can be profitably harvested; and for the fast-growing ones this period may be set down as not less than sixty years. These charges are: compound interest on the money invested in land and planting, care and labor in management, and annual taxes; and when these are summed up, it will be found that the total cost will at least be equal, and probably will exceed, the price for which that character of lumber and other forest products can now be purchased in market.

If we cannot, at present prices, afford to engage in tree-planting, we are naturally led to inquire whether we can reasonably anticipate that any one or all the important features mentioned will be changed in the future. While a positive and definite answer to this query would be more or less conjectural, there are certain things which, when well understood, will lead to such a comprehension of the case as will greatly aid in forming a reasonably accurate opinion; and it will be well to consider them seriously, for, unless it can be shown that the cost of production will not be greater than now, and that prices for forest products will be increased by the time they can be grown, there need be no expectation that tree-planting will be undertaken as a financial proposition. If the future cost of forest products will be the same, or greater, and the price for these be the same, or less, than now, the only one, except the state, who will be likely to engage in tree-planting is the farmer who, in the near future, must begin to grow his fuel, posts, and other necessary wood for his farm.

In reckoning the future cost of forest products it will be safe to assume that interest on the money invested will not be greater — more likely less — than now, that the rate of taxation will be substantially the same, and that the only probable difference in cost will be that for labor. Of this latter feature we can judge only from the experience of other countries, which is that the denser the population the lower is the rate of wages for common laborers. From this fact it will be safe to conclude that for the next fifty to seventy-five years the rate of wages in this country will be little if any higher than now, and possibly lower. Therefore, all things considered, it may be reasonably concluded that the cost of forest products fifty to seventy-five years hence will be substantially the same as at present.

It remains, then, to determine, as far as possible, whether the price of forest products will, in the future, be less, or the same, or more than now. Two important features are always connected with — and in fact control — the price of

necessary articles in market. These are demand and supply. This is so well understood that no demonstration of its truth is needed. What, then, will be the probable demand for forest products fifty to seventy-five years from now? Is it likely to be less, the same, or greater than now? It is hardly conceivable that it will be less, or even the same, and the probabilities are that it will be greater, for there is room in our vast domain for a large increase of population, and statistics show that our population is now more than five times greater than it was seventy years ago. Of course it must not be claimed that such a rate of increase will continue for long in the future; but it is certainly within the bounds of reasonable probability to assume that our population will, in seventy-five years, be nearly twice what it now is. This would bring a greatly increased demand for forest products, even if the amount consumed per capita should be lessened by one third, which is hardly probable. From this it will be safe to conclude that there will be an increase of demand here at home, and under no conceivable conditions or circumstances can we expect that the demand will lessen in foreign countries so that we can draw a supply from them, for it will naturally increase there too; and that increase of demand will assuredly cause an increase in price unless the supply is sufficient to meet it.

If the demand is to be greater, will the supply be ample? With every European country, except Norway and Russia, consuming more than their forests produce, with only India and Japan, in Asiatic countries, having an ample supply, and in North America only Canada possessing more than its own needs demand, — and the latter compelled to give the mother country any surplus she may possess, — and with our own country consuming her forest products more than three times faster than they grow, what right have we to conclude that the supply will, in the future, equal the demand? The awful fact is, that the whole civilized world is confronted with a disastrous timber famine in the near future.

Present prices for forest products should be no criterion for the future. It would be fair to insist that they will increase in years to come just as they have in the past, but that may be set aside as having no particular significance as to future prices unless resting upon conditions which must exist in the future; and there will inevitably be conditions which cannot be ignored. When the forests of this country become exhausted, even to the state that European forests now are in, the price of forest products will then depend upon the cost of production—the cost of growing trees—just the same as for any other product of the soil. If any one grows wheat, corn, cotton, hay, or any other farm crop, the consumer must pay the cost of production, plus a profit, and it cannot be otherwise here when the virgin forests which cost nothing to grow are exhausted.

Logically the cost of growing trees for lumber should govern present prices, now that virgin forests are nearly extinct, but as the forests of the past cost nothing to produce them, no additional price has been added to the cost of manufacture, other than a small amount which has been denominated stumpage, and the profit which the manufacturer and dealer have been able to secure. The superabundance of forests has prevented much increase of cost, but when they are gone, the cost of production will assuredly control. And that period will certainly be reached by the time new forests can be grown. Therefore, it is no unreasonable conclusion that a forest planted now or in the future will be a profitable financial enterprise. They are profitable in Europe under less favorable conditions than will surely exist here in seventy-five years from now. The price there is now, to a certain extent, controlled by importations from other countries. When such importations cease, as they will in time, the price in Europe must advance; and so it will here when the present forests are exhausted. After that the ruling price must be the cost of production with profit added.

PART II

THE PINES

FROM the earliest knowledge of American forests the several species of Pine have held first place in the estimation of lumber manufacturers, dealers, woodworkers, consumers, and the general public. No other lumber-producing trees have played so important a part in the economic and industrial advancement of this country. Until recently there has been more pine lumber annually manufactured in the United States than of all other kinds combined; and even now, after our pine forests have been greatly reduced in area and productiveness, the amount manufactured in the United States in 1908 was forty-eight per cent of the total cut.¹

All Pines are not alike valuable. Out of thirty-seven species indigenous to the United States not one half of that number can be deemed of sufficient importance to justify any attempt at cultivation. Really but few of them are of such economic character as to warrant it. They all belong to the botanical class known as "conifers," or cone-bearing trees, the cone being composed of a woody stem covered with scales that overlap each other, inclosing the seeds at the base of each scale, the fruit of all of them requiring two years to mature. Another distinctive feature is that their leaves are in the form of needles, clustered and held together by a sheath and are never shed at the end of the first year, — sometimes not under three years, — and hence are called "evergreens." In all but one species the leaves are in clusters in the sheath, ranging from two to five in each; the exception being the "Nut" or "Pinyon" Pine (*Pinus monophylla*) of the Pacific Slope, which has a single leaf. It is of no value as a timber tree.

A correct distinction would place our commercial Pines

¹ *Forest Products of the United States*, 1908, No. 10, Bureau of the Census.

in two classes, Soft Pines and Hard Pines. There is a difference not only in the character of the wood, but in the foliage, bark, and general appearance. Nearly all the Pines have more or less of a sticky, limpid, clear substance in the sapwood and live bark, known as crude turpentine. There is less of this in the Soft than in the Hard Pines, and in all the amount varies with the species. As the sapwood changes to heartwood a large part of the volatile portion of the crude turpentine disappears from such wood, leaving in the heartwood what is known as resin.¹ It is the presence of a comparatively large amount of this resin that gives a distinctive character to the Hard Pines. It causes the heartwood to take on a darker color, adds to its weight and hardness, — but this latter feature makes it more difficult to work yet better able to endure wear and abrasion, — and enables the wood to resist decay more successfully, when exposed. There is also a more marked distinction between spring and summer wood in the Hard than in the Soft Pine class. There is some resin and turpentine in the Soft Pines, but much less than in the others.

The lumber trade has adopted a different classification and both manufacturers and dealers now classify pine lumber as “White Pine” and “Yellow Pine.” So far as character and quality of the wood in Soft and White Pine are concerned, the terms may well be considered synonymous. They include only what are known as Eastern White Pine (*Pinus strobus*); Western White Pine (*Pinus monticola*); and Sugar Pine (*Pinus lambertiana*). There is so close a resemblance in the character of the lumber cut from all of these species that no serious wrong will be inflicted upon the consumer should either be given him. It is not so, however, with the Yellow Pine class. Under that name will be found Longleaf Pine (*Pinus palustris*); Cuban Pine

¹ As commercially known “resin” is the solid portion left from the distillation of the crude turpentine which fills the cells and pores of the sapwood and live bark of the several species of Hard Pines, and which runs out when an incision is made therein. The other product is “spirits of turpentine,” and the two constitute the well-known “naval stores.”

(*Pinus heterophylla*); Shortleaf Pine (*Pinus echinata*, quite frequently called North Carolina Pine); Loblolly Pine (*Pinus taeda*, sometimes called Oldfield Pine); Pitch Pine (*Pinus rigida*); Western Yellow Pine (*Pinus ponderosa*); Lodgepole Pine (*Pinus murrayana*); and Red Pine (*Pinus resinosa*, largely called Norway Pine). To claim that lumber cut from each of these species is alike in value is to claim what every one familiar with all of it knows cannot be truthfully admitted. There is certainly a marked difference and one which will be pointed out when separately discussing the species. Professor Charles S. Sargent¹ classifies the Pines as "Soft Pines" and "Pitch Pines," which is far better than the lumber-trade classification, for it gives the consumer a fair idea of what he is getting. Each species should be designated by its true name and then no one will be wronged.

WHITE PINE: *Pinus strobus*

FORTUNATELY this tree is not burdened with numerous local names. It is called White Pine in every state of our Union except North Carolina and Tennessee. In North Carolina it is known as Northern Pine and in Tennessee as Spruce Pine. All things considered, it stands at the head of the list for general usefulness as a timber tree, not only for the character and quality of the lumber it yields, but because it can be easily and quickly grown by artificial planting or seed-sowing. It is indigenous to America, but it is grown in Europe and is there known as Weymouth Pine, so named for Lord Weymouth, who introduced it into England soon after the English colonies were established in America.

A line bounding its natural range runs from eastern Maine southward along the Atlantic Coast to the mouth of Chesapeake Bay, thence along the eastern slope of the Appalachian Mountains to northern Georgia, thence along the

¹ *Manual of the Trees of North America.*

western slope of those mountains to West Virginia, from there in a northwest course across southern Ohio, central Indiana, and Iowa to the western line of Minnesota up to the Canadian line, and from there along the northern border of the United States eastward to the Atlantic Ocean. There are some outlying tracts not included within these lines in which it grows and also some localities included where there is none to be found. In a general way, however, the territory embraced in the boundaries given may be considered as covering the original White Pine region. There is no doubt but that its botanical range is greater than noted, and that its area can be considerably increased. It thrives in England, France, and the German Empire. It does not grow equally well, however, in all sections of our country in which it is found, yet it will grow in a greater diversity of soils and situations than any other valuable timber tree. Its best development has been found in Maine, southern New York, central and northern Pennsylvania, northern Michigan, Wisconsin, and Minnesota. South of Pennsylvania, Central Michigan, and Wisconsin it has been neither as abundant nor as large and valuable, but, for all that, it is well worthy of cultivation there. While it grows wonderfully rapidly in early life on the southern Appalachian Mountains, it loses its vigor in middle life and does not reach the size it does farther north. Besides this, the wood frequently becomes red in the heart of the older trees and is not so easily worked. It is seldom found growing below fifteen hundred feet above the sea in its extreme southern range.

It flourishes best in fertile, well-drained soils where its roots can reach a full supply of food and moisture, but it will grow remarkably well on dry sandy soils and gravelly hillsides. Anywhere in its natural range, except where very wet or where exposed to severe winds on high ridges and mountain-sides, it may be depended upon to grow with promise of good results. It will grow even in swamps and on sand hills, but its growth there is slow and uncer-



TEN-YEAR-OLD WHITE PINE PLANTING NEAR MONT ALTO, PENNSYLVANIA
On Pennsylvania State Forestry Reservation. Work of the students of the Pennsylvania State Forest Academy.
Courtesy of Pennsylvania Department of Forestry.

tain. When in favorable situations it attains an age of three hundred or more years, and grows to a height of one hundred and fifty feet, with a diameter of five feet. Greater heights and diameters are recorded, but they are rare. In the average forest it has not often been found over three feet in diameter or more than one hundred and twenty-five feet high. When grown closely surrounded in its early life by trees of its own or other species it will be tall and straight, with little taper of stem, and clean of limbs for fifty, sixty, seventy feet, or even more, from the ground. It was from such trees that the "panel" boards and planks of old-time lumbering days were cut, and from such came the tall masts — some of them one hundred and ten feet high — that held aloft the sails of many a gallant ship.

Whoever has once seen the soft, flexible, dark green leaves of the White Pine will never forget them. They are from three to five inches long, encased in a sheath at the base, invariably five in number, and when all are pressed together form a cylinder, each leaf occupying one fifth of the space inclosed by the sheath. They fall in early autumn of their second season.

The limbs have heartwood and sapwood the same as the stem; the heartwood of those next to the stem is more highly charged with resin than any other part of the tree, and if the limbs are permitted to grow to any considerable size they will not drop off, if they die, as the resin prevents their decay; such limbs cause the objectionable black and loose knots in the lumber.¹ Close planting is the only remedy for this. Early shade causes the limbs to die before

¹ It is a singular fact that the limbs of a close stand of White Pine will not drop off as quickly in some sections of the country as in others. This is notably so from central Pennsylvania southward. The reason for this may be that in the warmer regions there is more resin in the limbs and, hence, they do not decay as rapidly. The claim that White Pine will clean itself more satisfactorily when planted with other species is not necessarily established. While it cleans itself well there, the fact remains that it will do so when in a pure stand, if planted close enough. In each case the result is determined by the amount of shade in early life. The limbs should be killed when small, and before the resinous heartwood in them is large.

there is enough resin in the heartwood to prevent their falling off as soon as the sapwood in them decays. Dense shading of the lower limbs must begin in early life and be kept up until a satisfactory height of clean stem is secured.

Lumber cut from trees grown in the open, or not sufficiently crowded in early life, is much less valuable than that from trees that were properly shaded and, consequently, had dropped their lower limbs, thus permitting wood to grow on the stem free from knots. Open-grown trees are full of large knots and have a large proportion of sapwood. Besides, the heartwood of such is very soft, weak, and brittle, a condition which has led to a widespread belief that second-growth White Pine can never furnish lumber that can take the place of that found in our virgin forests, a mistake that may take a long time to correct in the minds of the consumer and woodworker. When crowded in early life the annual layers will not be so thick as when grown in the open and the character of the wood will be materially different in texture and strength. Age, however, seems to have something to do with the character of White Pine lumber. Probably some kind of chemical agency is at work modifying the heartwood after it ceases to perform any function towards supporting the life of the tree. No matter what the cause for any change may be, if it occurs, close planting and judicious thinning will unquestionably produce good lumber, while neglect of these will assuredly end in failure. It is not unusual to see trees not more than five or six inches in diameter breast high, free from limbs for thirty, forty, or even more feet, in a naturally closely planted grove of White Pines, thus laying the foundation for clear lumber; and whether natural seeding or artificial planting prevails, the result should be the production of such trees if success is to crown the efforts put forth.

After the first few years of its life White Pine is a rapid grower. Its annual rings, however, show a gradual and constant decrease in thickness as age creeps on. This does not necessarily imply that less wood is formed annually,

for the increased diameter of the tree gives a greater area on which it is to be deposited and the accretion must cover more surface. The total amount of annual accretion increases quite regularly until the tree reaches the age of seventy-five or eighty years, and sometimes more, and then the amount of wood annually laid on appears to be quite uniform until an age of one hundred and twenty-five or one hundred and fifty years has been reached, when it begins to lessen, and continues to do so from that time on. This conclusion has been reached by a careful and patient examination of the annual rings of a large number of forest trees which were being cut for lumber, and in widely different regions.

The wood of the White Pine is soft, not strong, straight and fine-grained, moderately durable, light, shrinks but moderately, and does not warp or split in seasoning or when a nail is driven into it close to the end. It is easily worked and takes glue and paint well. If varnished without stain its light, buff-colored heartwood gradually turns a rich transparent brown, closely resembling mahogany in color, with a rich satiny lustre. No wood, unless it is oak, has been so abused with stains and paint as White Pine when used for interior finish. Few woods can equal it in richness of color and texture when properly treated and time given it. For a long time it was the only softwood that lumbermen and consumers of the Northern States would consider of any value. It was used for a wide range of purposes, — probably none ever used for so many, — and it would still be so used to-day did not its scarcity and high price prevent. To enumerate all the uses it can be put to would be to name about everything wood is used for except where great durability when exposed to the soil is demanded, or where strength, hardness, and toughness are exacted.

The sapwood is slightly lighter in color than the heartwood and does not darken so much with age. It is quite highly charged with turpentine. The change which occurs

when sapwood is converted into heartwood eliminates, in some way, much of the volatile portion of the turpentine with which it was stored and the heartwood is left comparatively free from it. There is little difference between spring and summer wood in color or hardness, and this makes it easy to work. The medullary rays are small, numerous but not conspicuous.

Some virgin White Pine produces wood softer than the average, and that fact has led to the belief by some that there are several varieties of that tree. This may be true, as it is well known that there is a difference in the wood, and old lumbermen and woodworkers agree that "cork pine" or "pumpkin pine" is quite superior in quality to any other. Still, this difference may come about through age or surroundings. Such wood is usually, but not always, found in trees that stand apart from their kind — frequently among hardwoods — and are old and near the end of life. The matter is well worth investigating, for there is occasionally a marked difference in the character of the wood.

Unfortunately for natural reproduction the tree does not produce seed in early life. While it occasionally bears cones before the age of twenty years, fertile seeds will seldom be found in them ; and only when growing in the open can it be depended upon to bear seed before the age of thirty-five or forty years. At the best, it is not a prolific or a regular seed-bearing tree. Only once in five or six years can it be relied upon to produce a crop. A tree blossoming in the spring of one year does not perfect its seed until late in the summer of the succeeding one. The cones do not attain a growth of over three fourths of an inch in length and five sixteenths of an inch in diameter until the spring of the second year. They then begin to grow very rapidly and by the first of August will reach full size, which runs from five to seven inches in length — sometimes eight inches — and from seven sixteenths to one and one eighth inches in diameter at the largest part. They are of a bronze green in color until they open, and they then turn to a bright brown.

As soon as the scales open the seeds drop out, but the cone remains on the tree until the next spring. There are two seeds at the base of each scale, but those at the ends of the cone are not always fertile. The seed is about the size, and quite the same color, of an apple seed, and to it is attached a thin brown wing about one fourth inch wide and from three fourths to one inch long. This wing is so formed that when the seed falls from the cone a gyrating motion is set up, causing it to fall slowly, and giving the wind a good opportunity to carry it quite a distance. Instances can be shown where the wind has carried the seeds a full half-mile.

The scales usually open about the last week in August or the first week of September, varying according to the weather and latitude. If dry they open early, and if wet they may not for a week or ten days later. If seeds are to be gathered the cones must be secured before the scales open, for then the seeds drop out. As soon as collected the cones must be placed where they will dry readily. They should be spread out thin, and in no case be allowed to heat or mould, for if either occurs the vitality of the seeds is greatly lessened if not totally destroyed. The cones must be placed where the sun can shine on them or in any dry place where neither birds, squirrels, nor mice can get at them. If a room can be provided where a temperature of seventy-five degrees can be kept up, with good ventilation, the opening of the scales will be greatly hastened. If laid on a wire screen to a depth of three inches, and frequently stirred, nearly all the seeds will drop out; but if they do not, the cones may be put into a common grain bag and a few vigorous blows given on some hard object, when substantially all will be freed. The wings must then be rubbed off and all dirt cleaned out and the seeds put in a bag and hung up in a cool, dry place until planting-time. They should be thoroughly dry before they are put away. Where a large number of cones are to be cared for, a room with artificial heat should be provided, and the cones placed on screens and racks and frequently stirred. Ample ventila-

tion should be maintained while the cones are being dried. White Pine is a slow grower the first few years of its life. It seldom exceeds two inches in height the first year, and generally grows not more than one inch. By the end of the third year a height of four to six inches may have been reached. An increase of four or five inches may occur the fourth year, and the fifth should show a total height of twelve to fifteen inches. In the sixth year it may add twelve to eighteen inches, and after that a growth of two feet a year may occur until the tree is thirty or forty years old, providing it has not been crowded by other trees. It throws out a whorl of limbs — most generally five — at the beginning of each year's growth after the fourth or fifth year of its age, and until the tree attains a height of forty to fifty feet — if close-grown — these whorls of limbs give an approximate indication of the tree's age, each whorl representing a year. On an average the tree will have attained a height of five feet in seven years. The buds for these whorls — called winter buds — can be seen at the end of each season's growth. There is seldom a bud formed on the stem between these whorls.

The root system of the tree accommodates itself to local situations. In ground with a clay subsoil its roots will run shallow, but in deep, fertile ground, not too moist, they go down deep. Frequently on alluvial deposit, where the water-bearing stratum is low down, stumps pulled out bring ground from a depth of five or more feet. Its demand for mineral food is very light, and when opportunity is offered, it seeks what little it requires far below the surface.

White Pine tolerates other species of trees for its near neighbors. It grows equally well with such as do not make a more rapid height growth as with its own kind. In transplanting it into the forest it might be well to mingle with it other species of trees possessing the same rapidity of growth; but this would seem advisable only for the reason that attacks of fungus diseases and insects are not generally as severe in mixed stands.

The distance apart that the young trees should be set in the forest depends upon the location and character of the soil. It is at all times desirable to secure a covering for the forest floor as soon as possible, and if the ground is not fertile, closer planting than would be suitable where all things are favorable may be advisable. The distance may range from four to six feet, or compromising on five feet. Plantations have been set out in this country from three to sixteen feet apart each way, and neither extreme has succeeded well. As soon as the trees show any lessening of height growth, or show any signs of serious interference, thinnings should be made, to relieve those selected for the permanent ones from the struggle for supremacy, and even existence. The condition of the leader is a good indication of the tree's vigor.

It may be thought that undue importance has been given to this tree. The reasons for so much being said are, that in quality of lumber it is the best of all the Pines; it has a greater range of usefulness and adapts itself to a greater variety and condition of soil than any other; it is the most rapid grower of any of the White Pine family and can be more readily grown by artificial methods than any other; and, furthermore, it is the only one which has been successfully grown in that way. All in all, it stands at the head of the list of the important timber trees of the United States.

WESTERN WHITE PINE: *Pinus monticola*

THIS tree has not been burdened with many names. It is almost universally known as White Pine, and the lumber trade will undoubtedly persist in calling it that on account of its great similarity to the popular Eastern tree; and it must be admitted that little or no wrong can come to the consumer should the lumber from the Western tree be given him instead. Mr. George B. Sudworth, dendrologist of the United States Forest Service, suggests Western

White Pine, which is highly appropriate. It is emphatically a Western tree, and its technical name, *Pinus monticola*, tells us that it grows on the mountains.

It may be found intermittently on the Coast and Cascade ranges of mountains from the Canadian line well down into California, in eastern Washington and northern Idaho and Montana. The region of its best development is in the three last-named states. The author saw fairly good specimens of the tree growing on the northern slope of Mount Shasta, but was informed that much better ones grew in northern Idaho and Montana. It is seldom found growing below 5000 feet above sea level, and sometimes reaches an elevation of 10,000 feet. It flourishes best along bottom lands and streams.

At its best it grows to a height of one hundred and twenty-five feet and a diameter of five feet, but these dimensions are seldom found. It has a slight taper of stem, quite free of large limbs, when grown in a dense stand, but in the open may have one or more large branches reaching out ten or more feet beyond the other slender ones. This peculiarity distinguishes the tree and makes it easily recognized at a distance. In many respects it resembles the Eastern White Pine and may be only a variation of that tree brought about by environment. Its cones, however, are much longer, sometimes reaching fifteen inches in length, but not proportionally larger in diameter than those of the Eastern White Pine. The seeds are about one third of an inch long, with a wing nearly an inch in length. The leaves are bluish green, from three to four and one half inches long, with something of a silver sheen, and, as with other Soft Pines, in clusters of five. The bark is thin and in mature trees broken into small square scales, in this respect being totally unlike that of any other Pine. The scales are readily blown off by winds and leave the stem of the tree a red brown color. Its thin bark, seldom an inch thick, makes it an easy victim for forest fires.

Like all other Pines it will, in early life, throw out limbs

close to the ground and these take on a drooping habit and will remain alive a long time, if the tree is not grown in close quarters. When young its crown assumes an upright conical form, somewhat like the Spruces and Firs, but as it approaches maturity in the forests the crown becomes quite flattened. There is no reason to think it may not clean itself of limbs by proper treatment, although it generally retains many until quite mature. Like the Eastern White Pine it is long-lived, frequently reaching an age of four hundred years, but it does not grow as rapidly.

The wood is generally darker colored than that of the Eastern species, being a light reddish-brown, with lighter colored sapwood. It is light, soft, easily worked, not strong or very durable, close- and straight-grained and easily split. There is little difference between spring and summer wood, and the medullary rays are small and inconspicuous. It can be used for practically all purposes to which any of the Soft Pines are devoted. When shipped East it is sold as White Pine and takes about the same rank as the Eastern species, few being able to distinguish them, although the wood is a trifle harder.

No information can be obtained concerning its propagation except that which has been experienced in attempting to grow it for ornamental purposes in the eastern United States, which has not been very successful. No effort to grow it as a forest tree is known to have been undertaken anywhere. Professor C. S. Sargent¹ says: "Occasionally [planted] in the eastern United States, where it grows more vigorously than any other Pine-tree of western America." This, however, does not necessarily indicate that it would be a profitable tree to plant away from its natural home, for very few of the Western conifers thrive east of the Rocky Mountains. This one simply does better than any other. But there is enough to encourage experimenting with it on our highest wind-swept mountains of the East where only the Hard Pitch Pines now grow.

¹ *Manual of the Trees of North America*, page 5.

There would seem to be no reason why it should not do well when planted in its natural habitat, or why it should be difficult to propagate or transplant, unless the lack of rainfall would make transplanting of doubtful success. If growing trees in a nursery and transplanting them should fail, seed-sowing should certainly succeed. Experiments should be made with both systems, for it is too valuable a tree to suffer extinction, and, besides, it is more than possible that no other tree as valuable can grow where it does. It is being rapidly cut in Idaho and Montana, but no information can be obtained that any effort is being made even to permit natural reproduction to take place, much less any to aid it. Unless something is done in that line the tree will, in good time, be practically destroyed.

There are several other White Pines in the mountain regions of the West, but, excepting the great Sugar Pine, they are of no great value, being small and scattered, and all grow on elevations ranging from 7000 to 12,000 feet above the sea. Not much is known of them and their usefulness is largely conjectural.

SUGAR PINE: *Pinus lambertiana*

WHILE this tree is best known by the common name here accepted, it has seven others, all suggestive of its distinctive features, but none so appropriately bestowed as Sugar Pine. John Muir, in his delightful book entitled "Our National Parks" (page 112), says: "The sugar, which gives name to the tree, exudes from the heartwood on wounds made by fire or the axe, and forms irregular crisp white candy-like masses. To the taste of most people it is as good as maple sugar, though it cannot be eaten in large quantities."

Its natural home is along the Coast and Cascade ranges of mountains in Oregon, and from there southward along the Coast and Sierra Nevada ranges to southern California. It is seldom found below 3000 or more than 10,000 feet



TYPICAL IDAHO FOREST

Western White Pine at left 2 feet in diameter, 160 feet high. Larch at right. Cedar in background, the latter with drooping limbs. Kamiksu National Forest. — *Courtesy of U. S. Forest Service.*



SUGAR PINE, KINGS RIVER, FRESNO COUNTY, CALIFORNIA

Courtesy of U. S. Forest Service.

above the ocean. From 4000 to 7000 feet appears to be the altitude best adapted to it. Its best development is, probably, along the western slope of the Sierra Nevada in the central and northern parts of California. The author saw some very fine specimens around the base of Mount Shasta. Mr. Muir, as above cited, speaks of the tree in the following literally accurate yet glowing terms: "In many places, especially on the northern slopes of the main ridges between the rivers, it forms the bulk of the forest, but mostly it is intimately associated with its noble companions, above which it towers in glorious majesty on every hill, ridge, and plateau from one extremity of the range to the other . . . — the largest, noblest and most beautiful of all the seventy or eighty species of pine trees in the world, and of all the conifers second only to King Sequoia."

In early life the tree is generally covered with rather slender limbs from the ground up, and though the crown is somewhat open it assumes a conical form. Its tendency to take that shape at that time is far greater than with our Eastern White Pine, but there is, in the main, less uniformity of form in mature trees than with most conifers. As it approaches maturity, however, it develops a peculiarity that always makes it recognizable. It throws out near the top, long, slender, but somewhat specialized limbs, which stand out horizontally or slightly drooping, with large pendant cones, in clusters or singly, at the ends. Sometimes these limbs reach out thirty-five or forty feet from the stem, branching mainly at the ends. The cones require two years to mature and hang on another year after that event, and thus emphasize that peculiar feature. One who has once seen a Sugar Pine with its outstretched arms, holding great drooping cones, will never forget the sight or fail to recognize the tree.

By all odds it is the largest and most magnificent of all the Soft Pines, and of the Pine family only the Western Yellow Pine can lay claim to rival it in size. It is claimed that trees three hundred feet high and twenty feet in dia-

meter have been found, but it is seldom that one two hundred feet high and seven feet in diameter is seen. Its rapidity of growth is about the same as that of the Eastern White Pine, but its long life — six hundred or more years — permits it far to surpass that tree in bigness. As age advances, its slender lower limbs die and fall off and the tree will show a clean, straight, and slightly tapering stem for one half of its height, and its crown loses its conical form, sometimes showing a broad flat top sixty or eighty feet across. This habit of dropping its lower limbs seems to occur whether or not it is crowded in early life, and makes the tree exceptionally valuable as a lumber producer. No other Pine can show such wide clear stuff, and it is surpassed in that respect by few other timber trees in the world.

The wood closely resembles that of the Eastern White Pine. It is light, soft, — but not quite so much so as its Eastern relative, — straight-grained, is easily worked, light red-brown in color, with rather thin, cream-colored sapwood, and with little difference in color or character between spring and summer wood. Its medullary rays are small and inconspicuous and it seasons well and shrinks moderately in seasoning. It holds glue well and takes paint and varnish admirably. It can be used wherever White Pine can be, and, while not fully equal to the latter in all respects, it is no mean rival, and it is superior in its ability to furnish wide stuff.

The cones are shaped almost precisely like those of the White Pine, but are very much larger, seldom being less than ten inches long and three inches in diameter, and frequently sixteen or eighteen inches long and four inches through the largest part. The seeds average about one half inch in length and three eighths inch wide, are flattened somewhat, and are esteemed a choice edible by men and animals. The wing attached to the seed is about three fourths of an inch long and one half inch wide. On account of the seeds being edible there is little hope of natural re-

forestation. In fact, the young growth now coming on cannot fill the place of the mature trees being cut. Indians, Chinese, Italians, and other men, as well as squirrels, make great inroads on the supply of seeds produced, and as the tree is not a prolific seeder, and does not bear when young, those not consumed fall far short of the amount needed for natural reforestation. Probably the electrically inspired Douglas squirrel is the worst offender. He never rests. As soon as the seeds begin to ripen he will, without fear or trembling, climb clear out to the ends of the long limbs where the cones always grow, and deliberately cut them off, notwithstanding that he may be one hundred or one hundred and fifty feet from the ground, and the limb the cone hangs on no larger than one's finger. If the noise of the falling cone does not attract some man or marauding beast the squirrel descends and secures the seeds.

It will be seen that this renders natural reproduction a slow and uncertain event, while forest fires may, and too frequently do, kill off the young trees that come forth. Efforts should be made to gather the seeds and plant them, but instead, they are sold in the markets of the towns and cities of the Pacific Coast the same as chestnuts are sold in the East. Unless seeds are sown or trees planted, the tree will become extinct as soon as fire and the axe of the lumberman can bring it about, which will not be long.

Efforts have been made to grow it in the East, but thus far success has not been achieved. Through lack of moisture in the atmosphere, or from some other not well-understood cause, it does not thrive in the United States east of its natural home. Professor C. S. Sargent¹ says: "The Sugar Pine has grown slowly in cultivation and shows little promise of attaining the large size and great beauty which distinguish it in its native forests." Very good results, however, have been obtained in Europe, especially in northern Germany, where there is, doubtless, more humidity in the atmosphere than in this country, east of where the

¹ *Manual of the Trees of North America*, page 6.

tree naturally grows. The seeds the author experimented with did not germinate well, but that may have been due to age or improper handling when gathered.

No advice can be intelligently given as to the distance apart the seeds should be planted or trees set out, for nothing, so far as can be learned, has been done in that line in its native domain. The habit of trimming itself as it grows old would indicate wider setting or planting than with the White Pine. A careful study of the tree in its natural habitat and in all its stages of growth, with a view to ascertaining what is requisite, must come before positive directions can be safely given on this point. It develops a tap-root in early life, which would indicate that planting seeds would be advisable, especially as in its native realm it must endure long seasons with little rain, during which planted trees would suffer, so that they would be likely to fail the first year.

LONGLEAF PINE: *Pinus palustris*

It is unfortunate that Longleaf Pine is loaded with so many names, the majority of which are ridiculously absurd. The United States *Forest Service Check-List of Forest Trees* enumerates no less than twenty-eight, and these are mainly bestowed upon it in the various localities where it grows. Away from its home it is, in the main, commercially known as Yellow Pine and Georgia Pine. These designations are also unfortunate, for there are other species of pine known to the trade as Yellow Pine, and the State of Georgia produces several other timber Pines. It would be far better if it should be called by its correct name, — Longleaf Pine, — for that is a distinguishing feature of the tree, and one that is possessed by none other, except the Cuban Pine, which in so many respects resembles the Longleaf in the character of the lumber cut from it that distinction in the lumber trade is unnecessary.

The natural range of the Longleaf Pine is entirely con-

fined to the Southern States, but in much of the region where it once flourished little can now be found, it having been cut off and followed by Cuban, Loblolly, and Shortleaf Pine, and various broadleaf trees; or the ground has been devoted to agriculture, or has become barren waste. Starting from Norfolk, Virginia, it was found along the Atlantic Coast in a belt averaging about one hundred and thirty miles in width, well down to the southern part of Florida, and thence along the Gulf Coast to western Mississippi, with varying outlying regions in northern Louisiana, eastern Texas, and northern Alabama.

Its best development was on the low "pine hills" and plains which are elevated from one hundred to sometimes six hundred feet above tide. It prefers a sandy soil with a porous subsoil fairly abundant in plant food, will accept one somewhat sterile if the subsoil is porous and moisture can be reached at no very great depth, but does not take kindly to a wet soil. It is exacting, however, in the matter of geographical location, rarely growing, except in northern Alabama, over one hundred and seventy-five miles from the coast, and cultivation outside of these limits should be entered upon with careful consideration. Atmospheric conditions, brought about by proximity to the ocean, undoubtedly largely control in the matter, yet the temperature may have considerable to do with it, as probably nine tenths of the area once occupied by it does not exceed two hundred and fifty feet above the ocean, and much of it is only one hundred and fifty feet.

Ordinarily its greatest height of stem is from one hundred to one hundred and twenty feet, with a diameter of two to two and one half feet. Sometimes it may be found to exceed this, but rarely. Probably the average of trees cut for sawlogs does not exceed twenty-three or twenty-four inches, breast high, with a height of eighty to one hundred feet. Such trees must be well on to one hundred and seventy-five or more years of age. From one half to two thirds of their total height is available for timber. The

stem of the Longleaf Pine in the forest is straight and but slightly tapering, and free from limbs fully, if not more than, one half its height, occasionally reaching eighty feet without a limb. When it has once reached the height beyond which it refuses to grow, it throws out large limbs, none of which are particularly specialized, but are branched and crooked, and have dense tufts of long dark green leaves at the ends. The leaves are frequently eighteen inches long, are in clusters of three, and inclosed at their base in a long sheath. They are so flexible that they hang down from the limbs, and even in the period of rapid growth the leaves of the "leader" hang over gracefully and plume-like instead of standing upright, as with most other Pines. The leaves are shed at the end of the second year. They are sometimes woven into coarse fabrics for mats and the like.

The wood is heavy and strong, among the Pines only the Cuban Pine equaling it in weight. None of the softwood conifers, except the Douglas Fir, surpass it in strength or stiffness, while in hardness and durability of heartwood, when exposed to the weather or in contact with the soil, it surpasses that excellent wood. It is tough, does not warp or split in seasoning, is straight-grained, with light red to orange-colored heartwood, and a lighter colored sapwood. The thickness of the sapwood, however, varies with the locality, and in all cases it is thinner in old than in young trees, and frequently proportionally less towards the top than at the bottom. There is a marked difference in both color and hardness of the spring and summer wood, the latter being more heavily charged with resin. The heartwood is highly resinous and the sapwood and live bark are well filled with turpentine. It is the large amount of resin in the heartwood that causes it successfully to resist decay, and the turpentine in the sapwood furnishes the naval stores of commerce. Old fallen trees may be found with the sapwood all decayed and the heartwood perfectly sound. A century may have elapsed since they fell. The annual rings are very distinct; the wood is moderately coarse-

grained, and its fibrous structure compact. The medullary rays are neither large nor conspicuous. In addition to its stiffness the wood is elastic. It is used for a large number of purposes. Its tall, straight, and stiff stems have long furnished masts for vessels. No better timber can be found for the construction of railroad cars. The heartwood is largely used for railroad ties, and it enters into heavy construction work, such as bridges, trestles, long beams, and the like. It is largely employed for inside finish, taking varnish well, and when the heartwood is properly sawed it has no equal for flooring, except Sugar Maple, which is superior in halls and other public places where great wear comes.

Longleaf Pine is emphatically a light-demanding tree, so much so that small trees — seedlings — are rarely found where the crowns of larger ones shade the ground. Its demand for light begins with its birth, and this insistence accounts for the absence of seedlings where the ground is shaded. Even when growing in the open its lower limbs will die and drop off on account of the shade of those above, leaving a fairly clean stem.

While the tree will sometimes bear cones at from twenty to twenty-five years of age, it cannot be depended upon to furnish an abundance of seed at that age, and when mature it is not a prolific seed-bearer. The cones are from six to nine inches long, slightly curved, and with thick, blunt scales carrying a sharp point or beak at the end. The seeds ripen in late summer and the cones open only in dry weather. If the weather does not prove favorable they may not open until the middle of autumn. The seeds germinate readily when under favorable conditions, and it is not unusual to find them sprouted before winter sets in. The cones should be gathered as soon as the seeds are ripe, carefully dried, and the seeds shaken out, for if they remain wet there is great danger that they will either sprout or mould. The seeds are larger than those of the White Pine, with proportionally larger wings. They are edible and are devoured by squirrels and other seed-eating animals.

Observation shows that natural reproduction is slow and uncertain. If the seeds are not sown in proper places, or are largely destroyed by animals, or are not frequently produced, a new crop of trees cannot be brought forth to any considerable extent. Another thing works against natural reproduction. If the seed falls in a suitable place and germinates, the young tree's struggle has begun at a time when it is least able to combat the foes which attack it. The young tree seldom attains a height of over seven inches in as many years from its birth. If cattle are permitted to tramp over the ground, or fire runs over it, — practically a sure event, for the "pineries" are almost certain to be burned over where there is enough material to burn, in order to furnish pasture for cattle, — the little trees are sure to be destroyed. Or, if the grass and weeds are very rank and tall, they may be suppressed.

Neither is artificial reforestation without its difficulties. Not another of our valuable timber trees has so pronounced a tap-root, one which so persists from youth to old age. As stated above, at the end of the seventh year of its life the stem does not often reach more than that number of inches above the surface, while the tap-root may have penetrated the ground that number of feet, and at maturity it frequently reaches a depth of sixteen feet; and, what is more, any interference with the tap-root is emphatically resented during the whole life of the tree. It does not appear to have the power to overcome any serious obstruction it may meet with in the ground. Even a clayey or impervious subsoil within a few feet of the surface will most seriously interfere with the tree's growth. After six or seven years of age it grows rapidly until it reaches an age of sixty or seventy years, when its annual increase in height begins to lessen and the annual layers are thinner. Of course this largely depends upon surroundings and conditions of soil, moisture, and the like.

As no interference with the tap-root will be tolerated, artificial propagation must consist entirely in gathering



ROUND, OR UNTAPPED, TIMBER—VIRGIN FOREST OF LONGLEAF
PINE, OCILLA, GEORGIA

Courtesy of U. S. Forest Service.

and planting seeds where the trees are to grow and where the young trees will be protected from their worst enemies, — fire and cattle. Gathering seeds and planting in hills — broadcast sowing would not be advisable — should be practically along the same lines as for other Pines. While its habit is to grow in groves of pure stands, it will submit to the presence of other species that do not deprive it of its needed light.

The future of the Longleaf Pine is not at all promising. It is the great turpentine-producing tree. The demand for naval stores will cause its ultimate destruction unless measures be taken looking to reproduction. The United States Forest Service has done good work in devising and introducing a more economical and far better system of harvesting the crude turpentine, one which saves not only more of it but injures the tree less than the old method. But the tapping must go on, and ultimately the tree is completely girdled and will die. For a long time it was believed that frequent tappings caused injury to the wood, and the lumber trade demanded that which was cut from untapped trees. This belief has been shown by the United States Forest Service to be erroneous. Tests show that no deterioration in any shape takes place in the wood in consequence of tapping trees for turpentine.

There is a constant and growing demand for heartwood timber cut from this tree for use for general construction, and especially for freight cars and railroad ties, — the latter requiring a tree fully fifteen inches in diameter, and it is seldom that more than one tie is taken from a tree. Besides this the trees are scarred and seriously wounded by the turpentine gatherer; they are also handicapped by slow growth in early life, and are subject to ruthless destruction by cattle and fire. Suffering in all these ways, the tree will soon become practically extinct unless those who have to do with it take measures to restore and care for it.

CUBAN PINE: *Pinus heterophylla*

CUBAN PINE has escaped the burden of many names, no doubt because it was long thought to be a variety of Longleaf Pine, and even botanists did not consider it a separate species until a comparatively recent date. There is no distinction made in the lumber trade. The most generally used local names are Slash Pine and Swamp Pine, the latter quite appropriate.

Its natural range is in a belt from thirty to one hundred miles wide from South Carolina along the Atlantic Coast to southern Florida and thence west along the Gulf near the Mississippi River. As this indicates, its natural home is much more restricted than that of the Longleaf. It is distinctively a coast tree, and the probabilities are that it cannot be spread much, if any, beyond its natural range. It prefers a moist, sandy soil, and even grows in swamps. Where the ground is not too wet, Longleaf Pine, which it closely resembles, will be found a congenial companion. Its leaves, however, are not as long, seldom being over twelve inches, and they are in bundles of twos and threes, inclosed in a long sheath. They are a glassy, deep-green color, and are shed the second year. They grow in dense tufts at the end of the branches, but are not so flexible or pendant as those of the Longleaf. On the average the Cuban Pine does not grow as large as the Longleaf and its stem tapers a trifle more; and not as large dimension stuff can be cut from it, although trees one hundred feet high and thirty inches in diameter are frequently found.

The wood is exceedingly hard for a Pine, if anything harder than that of the Longleaf, is strong and durable, but splits easily. It is heavy, — a green log will sink, — the heartwood light orange-red, with thick lighter-colored sapwood and very resinous. Thin stuff warps badly in seasoning unless carefully piled. It is used for substantially all purposes that Longleaf Pine is put to.

The tree is a prolific seeder; it bears cones early and

seldom fails to produce a good crop of fertile seeds each year. The cones are smaller than the Longleaf and have less curvature; nor do they open as readily, frequently holding some of their seeds for several months. Two years are required to perfect the seeds, which are quite triangular in shape, but the wings are similar in form to those of other Pines. If they fall where the sunlight reaches them, they readily germinate, but the tree does not, in either early or adult life, demand as much light as the Longleaf. The young plants grow rapidly. It is not unusual to see them from six to eight inches high the first year. At the end of the second year, twelve inches may be reached. It has a tap-root, but this feature is not strongly developed, which makes planting in the nursery possible. Natural reproduction will take place, however, if not prevented, but seed planting would give a more regular and uniform stand; this is desirable in order to compel all the trees to drop their lower limbs and form straight, clean stems, which will not occur if they are left to grow in the open. The distance apart should be about six feet.

SHORTLEAF PINE: *Pinus echinata*

NOTWITHSTANDING that it is encumbered with fifteen different names in the regions where it grows, the lumber cut from Shortleaf Yellow Pine is frequently mixed in the lumber trade with other Southern Hard Pines and sold as "Longleaf," "Yellow," "Southern," "North Carolina," or "Georgia Pine," as the conscience or lack of knowledge of the dealer may lead him to select. It is true that for some purposes Shortleaf Pine will serve as well as Longleaf or Cuban, and it is better than either Old-Field or Pitch Pine, but where strength, stiffness, and durability are required it is inferior to either of the first two named; but its great value as a timber tree should not be disputed. Its wide-spread distribution, adaptability to varied soils and surroundings, its wonderful power of reproduction, its

rapid growth, especially when young, coupled with the many good qualities of the lumber cut from it, place it high in the list of Hard Pines in economic importance. Taking everything into consideration it will probably play a more important part in the future lumber supply of this country than will either or both of the Longleaf Pines, notwithstanding that the lumber cut from them is of better quality.

Its natural range extends from western Connecticut southward along the eastern slope of the Appalachian Mountains to the coast of northern Florida, and from the southern end of the Appalachians to the Gulf Coast, thence westward to eastern Texas and western Arkansas, north to Missouri, from there eastward across Tennessee to the western side of the Appalachians, and thence northward along both sides of the Alleghany Mountains to southern New York. Although never abundant north of Maryland, some fine isolated specimens can still be found in northern Pennsylvania. By far the best development is west of the Mississippi River, in northeastern Texas, western Arkansas, and southern Missouri, and also in northern Mississippi and Georgia, although very excellent stands have been found throughout most of its entire range. In the southern localities named it covers more or less of the entire ground with a pure stand. In other localities it is associated with other conifers and broadleaved trees.

The tree sometimes reaches a height of one hundred and twenty feet, with a diameter of four feet, but these dimensions are not common. It seldom rises above ninety feet or has a diameter over thirty inches. It is less uniform in size and growth, and also in character of lumber, than some species, because of its great range, embracing varied conditions of soil, climate, and exposure. All this should be carefully observed before any attempt is made to propagate it artificially. The trunk is slightly tapering and in its mature years the tree shows a round top with large limbs about midway in the height of the crown, and smaller ones

both above and below, the latter gradually dying; but it throws out limbs between the annual whorls more frequently than any other Pine, thus making it difficult to determine its age by counting the latter. The crown is not much given to branching. It is fairly tolerant of shade and not so exacting as some Hard Pines. It grows rapidly when young, and hence can suppress its slow-growing neighbors when starting out in life on an even footing. Consequently, when associated with Longleaf Pine it practically supplants that tree. It will frequently grow more feet in height during the first six or eight years of its life than the Longleaf can in inches. Its demand for light is strong enough, however, to cause its lower limbs to die and drop off when crowded, giving a straight, clean stem, free from knots and limbs, for a large part of its height.

The tree does not seem to have fully determined on the number of leaves it should have in a cluster, as it frequently shows two and three on the same tree. Some of these begin to fall at the end of the second season, while others continue to drop for four or five years. They are from three to four inches long, — this gives the tree its appropriate name of Shortleaf, — slender, soft and dark bluish-green when mature. The cones seldom exceed two inches in length, and hang on the tree for years. They are borne in great abundance nearly every year and the seeds have a high percentage of fertility. As with all other pines the seeds have wings, but they are the smallest borne by any of the timber Pines and consequently are blown to a great distance. There are nearly twice as many seeds in a pound as there are of White Pine, while the wings are proportionally larger than those attached to that seed. Their light weight, comparatively large wing, and great abundance have much to do with the tree's extended range, causing it to cover the ground completely with a new growth when the old one is cut away and seed trees are left.

The wood is light, soft for a Hard Pine, close-grained, not strong, with light brown heartwood, and nearly white but

thick sapwood. All of these characteristics may and do vary with location. The heartwood is moderately durable, having more or less resin in it, but as in all other timber Pines, the sapwood decays rapidly when exposed. There is a marked difference between summer and spring growth both in color and hardness. The medullary rays are numerous but inconspicuous. Both heartwood and sapwood grow darker with age. It is used for substantially the same purposes as Long-leaf, except where great strength and durability when exposed are demanded, although much of it is by no means a weak wood, while its heartwood will resist decay fairly well. The lack of uniformity in character and strength is one serious obstacle to its more general use for heavy work. Lumber sawed from it should be promptly kiln-dried, as a fungus attacks the sapwood and rapidly discolors it. For a long time "blueing," as the discoloration is termed, was a serious drawback to its introduction, but now that modern ingenuity has overcome that, no objection is made to the sapwood for many purposes where not exposed.

As indicated, natural reforestation will rapidly take place if conditions are at all favorable, and if care were taken to aid Nature in that work there would be no need to resort to the expensive method of raising trees in a nursery or even to plant seeds where the trees are to grow. However, as the seedlings do not develop a tap-root of any importance until three or four years old, ample time is given to transplant before that is seriously in the way. Seed gathering and care of the same should be carried on along the same lines laid down for White Pine, and so, too, should planting and setting out trees be conducted, if it be found necessary or desirable. Seedlings one year old are amply large for transplanting. It is greatly to be regretted that so little effort is being put forth to aid this valuable tree to maintain its existence, which it will do if permitted.



LOBLOLLY (OLD-FIELD) PINE, SHANNON COUNTY, MISSOURI

Courtesy of J. B. White, President of Missouri Lumber and Mining Company.



SHORTLEAF PINE, SHANNON COUNTY, MISSOURI

Courtesy of J. B. White, President of Missouri Lumber and Mining Company.

OLD-FIELD PINE : LOBLOLLY PINE : *Pinus taeda*

AMONG all the twenty-two local names given to this tree none is more absurd than "Loblolly," a term of doubtful meaning at best. "Old-Field" is much more appropriate and a name which indicates a prominent characteristic of the tree, — its persistency in encroaching upon and occupying abandoned fields and open places. It is botanically known as *Pinus taeda* — torch pine — from the use of the resinous heartwood for torches. Commercially it is classed with the other Southern Pines and sold as "Yellow Pine," "Southern Pine," "North Carolina Pine," or "Georgia Pine." For some purposes there is no great difference in the value of the lumber, but if the consumer desires strong, stiff, durable timber, or first-class flooring, he will not find it in Old-Field as he would in Longleaf, Cuban, or even Shortleaf Pine.

Its natural range lies in a belt some two hundred miles wide along the Atlantic Coast from Delaware to Florida, nearly covering the latter state, and from there along the Gulf of Mexico to central Mississippi. It ranges over the entire State of Alabama, all of eastern Mississippi, and part of central and western Tennessee. There is a large area of it in Texas, with considerable in Louisiana, Arkansas, and Indian Territory. It may be found forming almost the entire stand in many places west of the Mississippi River. Along the coast it thrives in a moist and frequently wet soil, mixed with Shortleaf and Coastbelt Pines and broadleaf trees; but in northern Alabama, Mississippi, Tennessee, and west of the Mississippi River, it grows well on rolling and quite dry uplands, notwithstanding the fact that it thrives in a moist soil if the ground is not subject to overflow.

It is claimed that several varieties exist, distinguished mainly by thickness of sapwood, coarseness of grain, and rapidity of growth. All this may come, and doubtless does, from conditions of soil and location. It is less light-

demanding than any of the Pines growing with it, which feature greatly aids in giving it the victory in the struggle for existence. Yet, like all the other Pines, it must have light, and when grown in dense stands of its own or other species of trees, its lower limbs will die and drop off and the result is a slim, moderately tapering stem, with thick, crooked, and forked branches, that form a rounded crown when lifted above its competitors for light. The tree grows to a height of one hundred and twenty-five feet, with a diameter of five feet, but these dimensions are very rare. The size most generally cut runs from eighty to one hundred feet high with a diameter of fifteen to thirty inches breast high, and a stem suitable for lumber of forty to sixty feet in height.

It is a very rapid grower until after seventy or eighty years of age. It is not an unusual thing to find young trees ten feet high when only six or seven years old, and at ten years of age fifteen or sixteen feet, with a diameter of seven or eight inches two feet from the ground. In young trees the leaves are but little longer than those of the Shortleaf, which has contributed much towards confounding it with that tree. In mature trees the leaves may be eight or nine inches long, with three in a sheath.

The wood is somewhat variable, owing to its wide range, but in general it is brittle, weak, rather hard, coarse-grained, of about the same weight as that of Shortleaf, not durable, and with a marked difference between spring and summer wood, both in color and hardness. The heartwood is light brown, with nearly white sapwood of unusual thickness, the latter frequently forming seventy per cent or even more of the cubic contents of the mature tree. The heartwood is charged with considerable resin and the sapwood is well filled with turpentine which, however, is thick and does not flow freely. It is used for interior finish, box boards and veneers, general construction, and for most purposes where great strength or durability when exposed is not required. It must be kiln-dried as soon as sawed or "blueing" will

result. If properly handled, this will not occur, nor will it warp or split when seasoning.

It is an early and prolific seeder, frequently producing fertile seeds at the age of ten years. From that age on it can be depended upon for a crop at least every other year. The cones are longer and slimmer than those of the Short-leaf Pine, but are seldom over three inches in length. They open slowly on ripening, thus giving ample opportunity for the winds to distribute the seed in all directions from the parent tree. It is not unusual for cones to hold some seeds until the spring succeeding their maturity. Fertile seeds may remain in cones adhering to the tree for a full year, which greatly aids natural reproduction, as the seeds are sure to be widely scattered.

Natural reproduction can be depended upon if proper conditions are allowed to prevail, and little need be said regarding artificial propagation. The seedlings develop a tap-root from five to seven or more inches long the first year, which increases rapidly in succeeding years; hence transplanting from the nursery would probably be difficult. Only by gathering seeds and planting in hills can any practical aid be given, aside from permitting Nature to carry on the work, which she will do if seed trees are left and she is not interfered with. While not equal in quality to some of our Hard Pines, it possesses many valuable features, and, therefore, it is highly important that, wherever possible, efforts should be made to perpetuate it as an economic forest tree. When full grown it can endure forest fires remarkably well.

PITCH PINE: *Pinus rigida*

IF it were to stand only on its merits as a lumber-producing tree, irrespective of any other redeeming quality, Pitch Pine could not be considered of sufficient value to be classed among the timber trees of our country. There are other species of Pine which yield far better lumber,

grow faster, and are as easily propagated; but there are none east of the Mississippi River which will grow where this can or will so well maintain themselves against that foe of all trees, the forest fire. By its growth land unfitted for any other purpose can be utilized, the ground covered and protected from erosion, and a moderate yield of somewhat inferior lumber produced. It is not loaded down with a multitude of names, but is almost universally known by the one here given, although several others have been bestowed upon it. This name was undoubtedly hit upon because the wood contains more resin than any of its northern associates. Its botanical appellation — *rigida* — refers to the rigid character of its leaves.

The natural range of the Pitch Pine is not very extended, reaching from Maine to Ohio along our northern border, and south to northern Georgia and eastern Tennessee. Its best development is along the Atlantic Coast from Massachusetts southward to North Carolina. It was once found in pure stands in a large part of New Jersey, Delaware, and eastern Maryland. It is particularly adapted to sandy, sterile plains, dry, gravelly, stony uplands, and bleak and barren wind-swept ridges and mountain-tops, where what little soil may there be found is quickly dried out by persistent winds. Notwithstanding that it will grow to best advantage in the localities named, it is not averse to creeping into moist ground.

It seldom grows to a height of seventy-five feet or a diameter of thirty inches, although records of a height of ninety feet and a diameter of three feet are not lacking. In its youth the tree is quite symmetrical, but in its old age it is anything but graceful in form. Its crown is then unbalanced with branched, distorted, and specialized limbs. It is a light-demanding tree, but unless crowded it will be clothed with limbs from near the ground up. Its ability to withstand fire is very great. It is not unusual to see the bark of the stems blackened by fire for eight or ten feet above the ground and the tree's crown showing little lack of vigor,

the thick bark having served as a complete protection to it.

The heartwood is of a light reddish-brown color, sometimes heavily charged with resin, soft, brittle, coarse-grained, and that part filled with resin moderately durable, with a thick, yellowish sapwood—the latter frequently amounting to seventy-five per cent of the mature tree—which rapidly decays when exposed. There is a marked difference between the spring and summer wood both in color and hardness. The wood is used for rough construction, box boards, and the like, but, because of large knots, is not often suitable for finer work or where great strength is required. Trees of all dimensions, from six up to eighteen inches, are shipped long distances and used for mine props in Pennsylvania coal mines. The wood is also used for pulp, being superior to White Pine for that, and, when charcoal iron furnaces were in existence, for charcoal. From the undecayed heartwood found in the forests large quantities of tar were made in rude clay pits before the development of the “naval stores” industry in the Southern States.

The Pitch Pine is an early and persistent seed-bearer, often fruiting at the age of eight years. The cones are small and hang on the trees for several years. They open slowly when ripe. The seeds are small,—75,000 in a pound,—with proportionally large wings, which further their even and ample distribution. There are three sharp-pointed stiff leaves in a sheath. It grows slowly for the first three to five years, but when fairly established it shoots up rapidly, and on moderately fertile soil keeps up a good growth until old age sets in. It seldom lives more than one hundred years.

Artificial aid in reforestation can be successful only by gathering seed and planting, where the trees are to grow in the forest, for the dry character of the soil where Pitch Pine should be planted will preclude the possibility of successful transplanting from the nursery. After a fire has

run over the land, in late fall or early spring, seeds may be planted in hills and the seedlings will generally hold their own with such stuff as might come up, and after a few years will take possession of the ground. In gathering seed, care should be taken not to mistake Scrub Pine — *Pinus virginiana*, sometimes called Jersey Pine — for Pitch Pine. That tree seldom grows over fifty feet in height or over fifteen inches in diameter. The leaves of Scrub Pine are from an inch and one half to three inches in length, while Pitch Pine leaves are from three to five inches long, are invariably three in a sheath, stand out at nearly right angles from the branches, and are rigid and stiff.

RED PINE: NORWAY PINE: *Pinus resinosa*

As with nearly all valuable timber trees, this one is known by a variety of names. Probably the most common one is Norway Pine, a name wholly out of place, for it is not a foreigner but a native of North America.¹ The next most common is Red Pine; and this is strictly accurate, for the bark of the tree is of a reddish hue, its heartwood of a pale red color, and the sometimes profuse staminate blossoms are a dark red. It is by this name that the tree should be known. Unfortunately, too, its technical name is inappropriate. *Pinus resinosa* means resin pine, and why Red Pine should have been given that name, when its wood contains less resin than any other hard timber pine, is very strange. It suffers further in being wrongly named by some manufacturers and dealers, who occasionally mix lumber cut from it with White Pine and palm it off as such to customers who do not know the difference.

This valuable timber tree is rapidly disappearing from

¹ It is related that the name "Norway Pine" was given to the tree by a Spanish captain, who first found it. Its close resemblance to pines he had seen in Norway caused him to suppose it identical with such as he had seen growing there, which were, no doubt, Scotch Pine (*Pinus sylvestris*).

the United States. Before its great destruction by the lumberman's axe and succeeding fires, it ranged along our northern borders from Maine to western Minnesota, and south to southern Pennsylvania, southern Michigan, southern and central Wisconsin, and southern and northwestern Minnesota. Its natural habitat is essentially a northern one, but it is more than probable that it will thrive on the mountain ranges from Pennsylvania to northern Georgia and Alabama. It was not generally found in pure stands, but the late Professor Samuel B. Green, of the University of Minnesota, recently wrote me that he had seen tracts of it near Cass Lake, Minnesota, that must have carried fully fifty thousand or more board feet to the acre. East of the states bordering on Lakes Superior and Michigan it is much scattered, sometimes mixed with White, Pitch, and Yellow Pine, Chestnut, and Oak, and in northern Pennsylvania, frequently standing solitary and alone on a bleak, exposed ridge, far apart from its kindred or other species of trees. There is a fine virgin grove of this tree standing on the Normal School grounds at Marquette, Michigan, as shown opposite page 6, illustrating its characteristics of growth where it is largely in the open. It will grow in bleak, exposed situations where the soil is too poor and dry for White Pine. Dry ridges, steep declivities, mountain-tops, and dry sandy plains are its chosen home, although it will grow on almost any soil not too wet, as is evidenced where it is grown as an ornamental tree, wherein it is far superior to nearly all other Pines. Its willingness to adapt itself to varied conditions adds much to its value.

In early life it assumes a decidedly tapering form of crown, much like the Spruces and Firs, but if at all crowded it will drop its lower limbs and shoot upward with a tall, slim, slightly tapering stem, clean of limbs for full half its height, with its lowest limbs still dying if lacking light. None of its limbs are specialized or of great length. When placed with White Pine, in soil and situation suited to that tree, it will equal it in growth for the first thirty or forty years

of its life, while in sterile soil and on dry and bleak situations it will outgrow it at every period of its life until it reaches a diameter of about two feet, when its rapidity of growth is much lessened. It is most commonly found running from twenty to thirty inches in diameter and from seventy-five to ninety feet in height, although it has been known to attain a diameter of three feet and a height of one hundred and twenty-five feet.

The wood is strong, very close-grained, hard, a trifle heavier than White Pine when seasoned, and decidedly so when green, — for a newly cut log will sink, — elastic, but not durable in contact with the ground. The heartwood is pale red, with thin yellow sapwood sometimes nearly white. The medullary rays are quite conspicuous, more so than in any other Pine. The summer wood is slightly darker colored than the spring wood and perceptibly harder. It is used for general construction and for nearly all purposes where White Pine can be used, although because of its hardness, not as well suited for doors, sash, and the like. It is superior to White Pine for flooring, and, among the Pines only Longleaf and Cuban surpass it for that purpose.

The leaves are dark green, from five to six inches long, quite flexible, and with but two in a sheath. In vigorous growth this sheath is frequently three fourths of an inch long. It blooms in early spring, and the cones are ripe and may be gathered the last of August or early September of the following year. It will frequently begin to bear seed when twenty or twenty-five years old, but it is not a prolific seed-bearer at best, and the fact that the cones are nearly all on the very topmost branches renders collecting them very difficult. There is more difficulty in securing a supply of seeds of this Pine than of any other eastern species, and the price is correspondingly high. The tree is remarkably well adapted to natural regeneration. The seeds are not as large as those of the White Pine, but the wing is larger, which allows the wind to carry them to a great distance. Neither do the seeds all drop out as soon as ripe,

some remaining in the cones until midwinter. This prolonged falling of the seed gives the varying winds an opportunity to scatter them in all directions from the parent tree. This result is strikingly shown where Red and White Pine have occupied the same ground and seed trees have been left, the Red always preëmpting the ground with its seedlings, for the White Pine drops its seeds as soon as ripe and they are scattered only in the direction in which the wind may be blowing at the time. But if natural reproduction cannot take place through want of seed trees, then the seed should be gathered and treated in all respects as directed for White Pine. The tree has a tendency to develop a tap-root, but if the soil in which the plants are grown in the nursery is moist, that tendency does not manifest itself very strongly for two or three years, and they can be successfully grown and transplanted. Still, it may prove far the better way to plant the seed. It certainly will be if dry, exposed, sterile ground is chosen for the plantation. This is especially so if the ground proves to be stony and with little good soil in which to set the plants. The distances apart that the seed should be planted or the trees set should be the same as for White Pine. As White Pine is superior to it, all things considered, it would not be best to plant it where that tree will flourish, but the possibilities of the tree are great in certain sections where other valuable species will not thrive.

WESTERN YELLOW PINE: *Pinus ponderosa*

THIS important tree is loaded down with no less than fourteen local names. It is called Yellow Pine in seven of the states where it is most abundant, and Bull Pine in five. Why this latter name should be applied to any Pine — and it is to no less than seven different species — is past comprehension. To call it Yellow Pine is in entire harmony with the character of the tree and is in the line of accuracy. In the eastern lumber trade it is very properly des-

ignated Western Yellow Pine, and this appellation should prevail, that it may be distinguished from the Yellow Pines of the Middle and Southern States. Its botanical designation, *Pinus ponderosa*, is eminently fitting, for it is truly a ponderous Pine, and is overmatched by only one other of the Pine family, the great Sugar Pine. While it is botanically classed among the Hard Pines, the lumber cut from it stands intermediate in character between that from the Hard Pines of the Southern States and the White Pines already described; and, therefore, there is ample reason for bestowing such a name as will convey to the dealer and consumer a truthful idea of its character. It should never be palmed off as a soft or White Pine, nor for a hard, resinous Southern Yellow Pine. It has enough good qualities to enable it to stand as a class by itself.

It has a wide range in the United States, extending from the Canadian line southward to Lower California and from the Great Plains westward to the Pacific Ocean. East of the Rocky Mountains it takes on a somewhat modified form and is botanically known as *Pinus ponderosa scopulorum*; and on the mountains from southern Oregon to Lower California there is another near relative known as Jeffrey Pine (*Pinus jeffreyi*). These two so closely resemble the Western Yellow Pine, in character and habit of growth, and in quality of lumber cut from each, that they will here be considered as practically identical.¹

It is not alone a giant among the Pines, but also among nearly all other trees. It is known to have reached a height of two hundred feet, with a diameter of eight feet, and it is claimed that trees two hundred and fifty feet high and twelve feet in diameter have been seen, but such must be very rare. That it may reach a great size is certain, for, in

¹ "Jeffrey Pine is scarcely less magnificent in size than its associate, the Western Yellow Pine. Some specialists consider it a variety of *Pinus ponderosa*, which it resembles so closely in its habits and soil and climatic requirements that from the forester's point of view there appears to be no practical reason for distinguishing the two." — George B. Sudworth, in "Forest Trees of the Pacific Slope," page 47, *United States Forest Service*, 1908.



VIRGIN FOREST OF WESTERN YELLOW PINE AND DOUGLAS FIR, MCCLOUD RIVER
REGION, NEAR MOUNT SHASTA, CALIFORNIA

Photographed by Lee & Eastman, Sisson, California.

avored situations, it grows rapidly and uniformly and lives to the age of five hundred years. It grows from near sea level to 7000 feet above. It may be found growing on the top of dry ridges, on mountain slopes, on high mesas, in dry valleys, and in canyons. It thrives well in volcanic ashes, as will be seen around the base of Mount Shasta, on the headwaters of McCloud and Klamath rivers, and in the glacial moraines and drifts throughout the great mountain regions; but insists on a well-drained soil, as it requires little soil moisture, apparently less than any other of our valuable timber Pines. It is very variable in character and size and in quality of product, which is not to be wondered at when the diversities of climate, soil, and elevation in which it grows are considered. It is deep-rooted and can withstand the gales that sweep the sides and tops of the ridges and scour the valleys where it grows.

It is essentially a light-demanding tree. It insists on this during its whole life, but most after the age of fifteen or twenty years. Probably not to exceed fifty trees to the acre could be grown to full maturity. The crowns of mature trees do not frequently touch each other or those of other species. Like most other trees it sends out limbs low down in early life, and if continually in the open these branches persist for the full life of the tree and give it a low crown; but if grown in a close stand it will throw up a tall, straight, slightly tapering, massive stem, clean of limbs for nearly or quite one half its entire height. Under such conditions it will form an open crown, somewhat columnar, with specialized limbs which turn upward at their extremities. Frequently one or more large limbs may be thrown out, and above that point an open, clean stem is seen for twenty or more feet before other limbs are formed.

The bark on mature trees may reach a thickness of four inches. It is deeply furrowed and of a cinnamon-brown color. In early life it is so thin that fire works serious havoc, but the mature trees can endure a moderate ground fire and the foliage is so far above that the trees escape

serious injury. Western Yellow Pine is frequently found in pure stands, but it tolerates other species for neighbors if not too close. The extended area of its natural habitat makes it one of the most important trees of the great West. The leaves are borne in heavy, brush-like clusters at the ends of the bare branches, and are deep yellow-green, generally three in a sheath, but sometimes two, four, and even five. They vary from five to eleven inches in length and remain on the tree three or four years or more — Professor Sargent says four to nine.

The heartwood varies greatly in color as well as in other economic features. It may be found from a pale lemon-yellow to an orange-brown, and, while it is usually of heavy weight, wood may be found fully five or even ten per cent lighter. It is sometimes so light and free from resin that it is sold as White Pine and provides a reasonably fair substitute. The sapwood is nearly white and of varying thickness. Although not strictly applicable to all cases — owing to variability — it may be said of the wood that it is generally heavy, hard, fairly strong, brittle, and fine-grained, but not durable, although all these features may be different through varying conditions of climate and soil. There is some difference between spring and summer wood, but generally not enough to interfere seriously with easy working. The medullary rays are somewhat numerous, but not at all conspicuous. It is used for heavy construction work, railroad ties, telegraph poles, mine timbers, and for about all purposes to which a good, not very strong, but moderately hard Pine can be put.

It is a prolific seeder, bearing cones nearly every year, and an ample yield may be expected about every four years. Like most other Pines, it does not produce many fertile seeds before twenty-five or thirty years of age. After that its seeds are unusually fertile. The seed is not much larger than that of White Pine, but with a broader wing, which permits its being blown to a great distance. The cones open early in August of the second year and are vari-

able in size and color. Squirrels and birds consume large quantities, but in spite of that drain upon the supply, natural reproduction takes place readily and can be largely relied on if any reasonable care be taken to promote it. Mr. George B. Sudworth, of the Forest Service, estimates that a single tree will naturally reseed a quarter of an acre in a year. It is evident that planting seeds, where natural reforestation may fail for any reason, will be entirely successful, and that growing plants in a nursery and transplanting them into the forest would not be advisable, owing, in part, to the tap-root they have and to the great loss which must inevitably ensue through lack of rainfall when the little recently planted trees would most need it. Efforts have been made to grow the tree in the eastern part of the United States for ornamental purposes, but with such poor success that the attempt to propagate it for forest purposes should be undertaken on a very limited scale, until it is shown to be more frequently successful as an ornamental tree. It grows fairly well in Europe and is being quite extensively planted there. The species *jeffreyi* seems to do better than *ponderosa* in our eastern climate, and it is possible that the other variety—*ponderosa scopulorum*—may do well on high and exposed elevations. It certainly would be well to experiment in that direction, for it might serve where none of our eastern Pines will flourish.

LODGEPOLE PINE : *Pinus murrayana*

THIS tree is generally known by the common name here given. There are several other local names, but none so appropriate. The appellation "Lodgepole" arises from its characteristic habit, when in dense stands, of growing tall, smooth, and straight, but with a small stem, thus fitting it for lodge- or tent-poles. None of our western Pines have a wider natural range, nor are any of more diversified habits of growth. This wide diversion of habitat and character has led to much confusion, and to the claim that there are

several species quite similar ; but such a contention cannot be accepted. Mr. George B. Sudworth, United States Forest Service dendrologist,¹ declares that "the reproductive organs of the supposedly different trees are essentially the same. With no characters found in these organs to warrant a distinction of species, the other so-called distinctions depended upon are believed to be unworthy of serious consideration."

Its natural range in the United States — it is also found in Canada and Alaska — reaches from the Canadian line to southern California, and, intermittently where trees grow, from the foot of the eastern slope of the Rocky Mountains to the Pacific Ocean. Location, climate, soil, all appear to have much to do with its growth, character, and usefulness. It may be found on elevations from sea level to 11,000 feet above. On the Pacific Slope it is a low tree, and when in the open forms a dense pyramidal crown, with many-forked branches from the ground up, and is of no great commercial value. When grown in dense stands in its eastern habitat, it has a tall, clean, slender stem, with a rounded, short, and small-branched crown, sometimes attaining dimensions suitable for saw timber, but is usually from six to twelve inches in diameter. In some regions it grows larger, reaching a height of one hundred feet and a diameter of even three feet. The author has seen many dense groves in the Klamath and Mount Shasta region and but few trees were found over ten inches in diameter, and seldom were any seen as large as that. Where densely grown they are free of large limbs for more than two thirds of their height.

The wood is soft, variable in grain, fine in dense stands, and moderately coarse when grown in the open. On the Pacific Slope the wood is of a reddish brown, but in the eastern ranges it is a yellowish brown. The eastern wood is the lightest, has less resin, is straighter-grained than the western, and easily worked. It is used for general con-

¹ *Forest Trees of the Pacific Slope*, page 49.

struction when large enough for the saw, and for all purposes to which small, straight, and not very strong wood can be put. Growing as widely as it does, Lodgepole Pine is of much commercial value especially in regions where nothing better can be found, and fortunately, it is sold under its true name.

It is a prolific seeder, but may not open its cones for years unless the trees are killed by fire. When that occurs natural reproduction will take place to a greater extent than with almost any other tree, but it will not so happen when the trees are otherwise destroyed. It is practically the only species where reproduction mainly depends upon the loss by fire of the parent seed-producing tree. The seeds can endure considerable heat, and this heat seems essential to their release from the cones and probably aids in their germination. It bears seeds when quite young, and if properly cared for, and the ground burned at the right time, natural reproduction will usually be complete. As it is emphatically a light-demanding tree, it must be grown in close stands to be of commercial value. When it attains its proper height, growth thinning would be advantageous. It is not known that any attempt at artificial reproduction has been made. Where clean cutting has taken place, regeneration does not occur to such an extent as would be necessary to produce a stand sufficiently dense; and such trees as may be left for any cause are soon blown down or die from changed surroundings. Gathering and heating the cones to obtain the seed, and then planting them, or burning the tract before cutting, must take place to insure satisfactory reproduction.

SCOTCH PINE: *Pinus sylvestris*

THIS foreigner comes to us with high recommendations from the regions of its natural as well as its adopted home abroad. It is widely distributed throughout Europe and northern Asia, and is a very important timber tree on the

former continent. It belongs to the class of hard Pines, although not as highly charged with resin as many of them are. In its home it sometimes attains a height of one hundred to one hundred and twenty-five feet, with a diameter of four or five feet, and when grown in the forest may be clean of limbs for one third to one half its height. In some respects it has the characteristics of our Norway Pine, but is less liable to drop its lower limbs when growing either in an open or in a dense stand. It is of ironclad hardness and makes moderate demands upon the soil for mineral food, but prefers that of fair fertility with a well-drained subsoil. As it has not been grown to maturity for timber in this country, we know comparatively little about its economic value. Except in some localities in the Western States it has been planted for ornamental purposes only, and experience in that direction does not give promise of good results when attempts shall be made to grow it for lumber. It appears to grow well for twenty to twenty-five years and then shows signs of weakened vitality. Some groves planted for forest purposes in a western state have a large number of crooked and distorted trees. This may come from some injury or defect in the "leader," although crooks appear between the annual whorls of limbs; or it may come from improperly selected seed,¹ for it is claimed that seed from abroad is collected from dwarfed and defective trees because it can be more easily gathered from such. This may be so, and if it is there is a chance, through proper selection of seed, for the tree to be as valuable here as abroad.

In Europe the wood is strong, elastic, close-grained, not difficult to work, and in appearance somewhat resembles our Norway Pine. It is not durable when placed in contact with the soil, notwithstanding that it is a trifle resinous. It takes paint well, is used for nearly all building purposes,

¹ "Scotch Pine in the Baltic provinces invariably has straighter trunks and yields wood of a higher quality than the Scotch Pine of central Germany." — Raphael Zon, in *Forest Quarterly*, vol. ix, No. 2, page 217.



SCOTCH PINE IN DENSE STAND ON CAMPUS, IOWA STATE COLLEGE,
AMES, IOWA. NOTE CROOKED STEMS

Courtesy of Iowa State College.

and is esteemed a valuable wood. It furnishes the red and yellow "deals" of the United Kingdom. It is also chemically treated for railroad ties, and is being planted by some railroads in this country for that purpose.

It is a rapid grower and a prolific seed-bearer, frequently producing seed every other year. The seeds are small, running from 70,000 to 75,000 to the pound, with about fifty per cent of fertility. The wing attached to the seed is proportionally larger than the average conifer, which is an advantage in natural seeding, but notwithstanding these features, so favorable to natural reproduction, that method of propagation is not generally followed abroad, for the tree is easily grown in the nursery and bears transplanting remarkably well. Plants may be set out in the forest when two years old, or may be left in the seed-bed for another year, but they would best be removed from there and placed in the transplant nursery, there to remain for two years, when they will be strong enough to withstand severe conditions in the forest. It is a much more rapid grower in early life than our White Pine, and seedlings three years old generally range from eight to twelve inches in height. Propagation and planting in the forest is carried on in Europe substantially the same as for White Pine.

THE SPRUCES

WHEN all things concerning our native Spruces are taken into account, there will be found but four of the seven species of sufficient economic importance to justify consideration; and there are certain features pertaining to these four which render questionable any effort at reproduction, other than in aiding Nature by leaving a sufficient number of seed trees, by planting seeds where seed trees are absent, and by protecting from fires at all times. But the economic importance of the four species, and their power to reproduce themselves when afforded an opportunity, should impel a vigorous effort to bring about so desirable a result. Those worthy of consideration are Red Spruce (*Picea rubens*); White Spruce (*Picea canadensis*); Engelmann Spruce (*Picea engelmanni*); and Tideland Spruce (*Picea sitchensis*).

Until comparatively recent times the Spruces were not very favorably looked upon by lumbermen or consumers, and hence dealers and manufacturers made little effort to put lumber cut from any of them on the market. The constantly decreasing supply of Pine, however, caused more attention to be paid to other conifers, and it was then discovered that for many purposes Spruce serves as well as the coarser grades of Pine and for some uses better. About the same time that its good qualities as a timber tree were discovered, it was likewise learned that it was extremely valuable for pulp wood; that only Poplar—commonly called Trembling Aspen—was superior to it for that purpose. Then the destruction of the Spruce forests in the eastern United States was begun in good earnest and it has since been carried on with accelerating speed and thoroughness; and unless something is done to arrest that destruction, the virgin Spruce forests will disappear and the future

supply of that wood for pulp must come from such second growth as modern methods of cutting may permit and from Canada's waning supply. The Spruces east of the Rocky Mountains are slow growers,¹ notwithstanding a general belief and frequent assertion to the contrary, and this is especially so in early life, and the danger of exhausting the supply of pulp wood is great and imminent. To depend upon another country, and that country with a lessening supply to dispose of, is not a satisfactory condition of things to contemplate.

Although the Spruces are locally given various and absurd names, lumber cut from both of the eastern trees is known in the trade as "spruce," without distinction as to species. No material wrong can come to the consumer from this, as the only essential difference lies in the color, but putting ten or fifteen per cent of "balsam" in a consignment is quite a different proposition.

RED SPRUCE: *Picea rubens*

THE natural range of the Red Spruce comprises a wedge-shaped region, with the New England States and New York for the wide end and eastern Tennessee for the apex or sharp end. Throughout its range south of central New York it is confined to elevated regions, although it is seldom found on the very crests of the mountains. Its best development is to be seen in its northern habitat. As it requires a cool atmosphere, the region south of Virginia does not produce as vigorous a growth as that farther north. It never attains a very large size. Occasionally trees are

¹ In a paper read before the Canadian Forestry Association, February, 1909, Dr. B. E. Fernow, speaking of the growth of White Pine, adds: "The Spruce, a much slower grower, makes, under most favorable forest conditions, one inch in seven, or more frequently one in nine years, which would bring a nine-inch tree in the average to one hundred years. But in virgin forests, where competition among species and individuals retards development, one inch in twelve to fifteen years, and more, is the usual rate of growth."

found one hundred feet high and three feet in diameter, but the average of what are deemed mature trees is seldom above eighty feet in height and twenty to thirty inches in diameter. North of central New York, and in the New England States, White Spruce (*Picea canadensis*) is generally mingled with it, frequently up to forty or fifty per cent, but White Spruce in New Hampshire and Vermont is confined to the northern portion of those states. They can there be found in pure or mixed stands on the high slopes and tops of the mountains as well as in the swamps, while on the lower slopes, ridges, and intervalles they are mingled with Fir, Birch, Beech, and Maple. Notwithstanding that they are found growing in exposed situations, they are not as well calculated for such localities as where protected from strong winds, for they are shallow-rooted and liable to be blown down.

Like all others of the Spruce family, the tree puts on a stiff, formal, compact, and acutely conical crown when grown in the open, and when crowded it retains the same spire-like top of green limbs above the lower dead and dying ones. When growing in the open, the lower limbs, of which it has a generous supply, remain alive for a long time, but when crowded they die for want of light, but do not readily decay and drop off. This retention of its limbs causes knots in the lumber, but they are generally small and sound. The stem is straight, somewhat tapering, and free from large limbs, the tree rarely developing them.

The wood of the Red Spruce is light, close-grained, not strong, soft, with heartwood slightly tinged with red, and paler sapwood, which is usually of moderate thickness, although sometimes two inches thick in mature trees. There is little difference between spring and summer wood, and the medullary rays are small and inconspicuous. It takes glue and paint well. It is largely manufactured into lumber used for general construction where not exposed. When cut into beams and posts, it is apt to warp and twist in seasoning. Its greatest use is for pulp, and more Spruce

and Fir are consumed for that purpose than all other kinds of wood. The tree is a free seeder. Its cones are borne on the topmost branches, thus giving the winds an opportunity to carry the seeds a great distance. Like other conifers the seed has a wing, and in this case the wing is large in proportion to the weight of the seed. The scales of the cones do not all open at once, thus prolonging the period of seed-sowing. Natural regeneration of the Spruces, and the frequently accompanying Fir, can be fairly well relied upon on cut-over lands where fire does not succeed cutting, but where it does, the chances for it are slim indeed. The natural seed-bed for the eastern Spruces is the decaying vegetable matter, the rotting leaves, twigs, limbs, and trunks of trees, — the humus, — with underlying soil. Unlike most conifers the young trees do not take kindly to mineral soil at first; and when that soil only is offered, germination is uncertain and the life of the young tree doubtful. It is not unusual to see vigorous young Spruces growing on decaying logs in the woods, or a belt of them on the ground where a tree has decayed and spread itself on the soil. Thus it will be seen that even where seed trees have escaped the ravages of fire, natural reforestation is somewhat uncertain at best, and where fire has burned all the humus and killed all the seed trees, it requires no argument to demonstrate that a forest of like species cannot reasonably be expected to grow there except through planting seeds or setting out young trees.

As already stated the Spruces are slow growers, and this is especially true of this tree in its early life. Where weeds, grass, or other stuff will be likely to overshadow them, nursery-grown plants cannot be set out until five or six years old, and this will make such propagation expensive. Undoubtedly the best way to reforest burned-over land with young Spruce is to plant seeds, and where no fire has occurred and seed trees are not numerous, to supplement the work of the latter by planting. Young Red Spruce plants are being grown in some forest nurseries, but their

slow growth does not indicate success. If plants are to be grown in a nursery, humus from the woods would best be compounded with the soil of the seed-bed. The young plants should be screened from the sun the same as other conifers, and substantially the same treatment be given them. As they are light-demanding, close planting in the forest will cause their lower limbs to die and the trees will become suitable for commercial purposes. The cones should be gathered and treated like those of the White Pine.

WHITE SPRUCE: *Picea canadensis*

THE White Spruce ranges along the northern border of the United States from Idaho to Maine, but not farther south than South Dakota, southern Minnesota, Wisconsin, northern New York, southern Maine, and northern New Hampshire and Vermont, growing along the shore much farther south than in the interior, except on the Alleghany Mountains, where it reaches northern Virginia. Its extended area in Canada has given it its botanical name *canadensis*, which is entirely appropriate. It constitutes the great bulk of the forests of Alaska and northern Canada, reaching far into the Frigid Zone, where it grows on the tundras that are never free from frost. It is essentially a cold-climate tree and a southern extension of its range need never be expected. Its best development in the eastern United States is in northern New England, but it seldom attains a great size. Professor Sargent,¹ in speaking of it east of the Rocky Mountains, says: "Toward the southeastern limits of its range rarely more than sixty to seventy feet tall, with a trunk not more than two feet in diameter." It averages somewhat larger in Idaho. It is a slow grower, but long-lived. Its general characteristics of growth in the Eastern States and the uses to which the wood is put are so like those of the Red Spruce that a detailed description of it need not be given, except to say that its heartwood

¹ *Manual of the Trees of North America*, page 42.

is light, not strong, light yellow in color, and with scarcely distinguishable sapwood. In a few years it must produce a large portion of the wood cut for pulp in Canada. The tree can be easily recognized by the rank, and, to some, very disagreeable odor of its leaves. There is little need of artificial propagation if reasonable care be taken to keep out fire and leave enough trees for seed.

ENGELMANN SPRUCE: *Picea engelmanni*

SUCH lumber as is cut from this tree and shipped East is known in the trade as "Rocky Mountain Spruce." It differs botanically from the eastern Spruces and grows much larger, yet the lumber cut from it is very much like that in character and can be used for substantially the same purposes and can be produced in much larger dimensions. Its natural range south of the Canadian line is along the Rocky Mountains and the Cascade Range southward to northern Arizona and New Mexico, at elevations from 5000 to 10,000 feet above the ocean. On the lower altitudes it frequently grows to one hundred and twenty feet high and three feet in diameter, but on high ones it is little better than a shrub. This produces great variation in the character and quality of the lumber cut from it.

Grown in the open, it forms a broad-based, conical crown, with long, drooping, lower limbs produced in regular whorls spreading far out, and some even resting on the ground. If in a dense stand, it sends up a straight, somewhat tapering, clean stem, with a very short, contracted crown of small branches. It is a slow growing, long-lived tree, reaching an age of five hundred years.

The wood is soft, light, compact, but not strong, close and straight-grained, pale yellow in color, tinged with red verging to reddish brown, with thick sapwood hardly distinguishable from heartwood, and with little difference between spring and summer wood. Its medullary rays are more conspicuous than in any other Spruce. It is used for

lumber for all general purposes of construction. No information can be obtained concerning its fitness for pulp, yet there is little doubt but that it is suitable, as all Spruces thus far experimented with are. Its bark is quite rich in tannin, but as the bark does not exceed three fourths of an inch in thickness on adult trees, the yield will necessarily be light. This thinness of its bark renders the tree an easy prey to forest fires, which are too frequently permitted to spread over large areas of the Rocky Mountain and Pacific regions where covered with a dense growth of splendid trees. Whether the fires occur as "ground" or "crown," — the latter where it leaps from the top of one tree to another with the speed of a race-horse, consuming every leaf and twig, — the trees are killed outright and the ground left naked, to be covered by a growth of chaparral, or, in rare cases, by trees of other species.

The cones are produced in great abundance, but are confined almost entirely to the topmost branches of the tree. They open and release the seeds early in October. The seeds are small, with a large wing, and can be carried a great distance by the winds. No doubt natural regeneration would be ample if fires could be kept out and care taken to leave a sufficient number of seed trees. Artificial propagation, beyond planting seeds where the tree flourishes best, should not be undertaken except in an experimental way. However, it is one of the few western conifers that shows something of a readiness to grow elsewhere than in its natural home. Specimens of Engelmann Spruce are growing in the Eastern States and in Europe, giving some promise of success, but no information can be obtained of any attempt to grow it for other than ornamental purposes except in Europe, and there the planting of it in the forest has been so recent that nothing definite can be determined. It is with this tree as with nearly all the Rocky Mountain and Pacific Slope trees: Nature has provided for their abundant continuance, and, if permitted, she will accomplish it. The situation there is not like that east of the

Mississippi River. In the high altitudes and on the steep declivities, planting trees will not be likely to prove successful because of the comparatively slight rainfall, and the only aid that can be given, aside from keeping out the fires and leaving sufficient trees for seed, will be planting seeds where the trees are to grow. In the East nearly all the seed trees are gone, hence reforestation cannot there take place naturally, but the abundant rains make transplanting in the East not only possible but practicable, as experiment shows. There is no invariable rule to fit all cases. Our work must conform to surrounding conditions.

NORWAY SPRUCE: *Picea excelsa*

HERE is a foreigner which will undoubtedly find a permanent home with us and prove a valuable addition to the list of important timber trees of our country. A strong, hardy, and rapidly growing tree in its native home in central and northern Europe, Norway Spruce has thus far shown its ability to accept the conditions it must meet over a large portion of our country. Although it has been planted here mainly as an ornamental tree and for a wind-break, its vigor, rapidity of growth, and freedom from disease give proof that it will do well as a forest tree. In its European home it will, if allowed, reach a height of one hundred feet with a diameter of three feet, and occasionally it exceeds these dimensions; but it is seldom permitted to grow beyond two feet in diameter, because compound interest on the money invested in the plantation will, after that period, increase more rapidly than the increased value through growth of wood can bring to its owner.

It is known to thrive throughout the area bounded on the north by a line drawn from southern Maine through central New York westward to the Mississippi River, thence south to central Kansas, and from there eastward through Washington, D. C., to the Atlantic Ocean. It grows quite well south of the area named, but coming from

a colder climate it would be best to plant it in elevated situations to insure success. Fine specimens, however, may be seen growing in Santa Cruz, California. Throughout the territory named, it grows as rapidly on fairly fertile soil as White Pine, but is not equal to that tree in adapting itself to a great variety of soils and surroundings. In soils largely composed of vegetable matter, as are those of some of the Western States, it makes a vigorous growth at first, but in a few years shows signs of decay, possibly suffering for want of certain mineral food or, more likely, from over-stimulation. Neither can it endure a very dry or very sterile soil. In its native home in Europe it is found growing in the valleys and well up the mountain-sides towards the snow line, but diminishing in size and vigor as it ascends. While its ripened wood is of ironclad hardness, it occasionally gets caught in this country by late spring frosts, as it starts to grow early and the new shoots are tender.

Like all the Spruces, its crown takes on a pyramidal form, though not so acutely as some of our native Spruces. If grown in the open, it throws out a broad base at the ground, yet its lines will converge to a sharp apex at the top, which is surmounted by a naked leader of the present year's growth. It is much given to developing limbs between the annual whorls. When crowded, its lower limbs die quickly and drop off, as it is light-demanding, but if allowed to become large they will adhere and cause knotty lumber; hence crowding should begin early and be kept up until the tree attains its height growth. When grown in the forest, it maintains the conical form of crown, but much shortened. If properly crowded in early life, it may develop a clean stem for one half or more of its height, but, like our native Spruces, some of the limbs next below the live ones will persist in adhering. The stem is straight and of slight and even taper, and there are seldom any large or specialized limbs.

The wood is close and straight-grained and strong, but

not durable when exposed to the soil. The heartwood is yellowish white, varying somewhat in color with locality, with thin and quite white sapwood. There is little difference in color or hardness between spring and summer growth. The medullary rays are small and inconspicuous. It is of medium hardness but rather easily worked. In general characteristics the wood closely resembles that of our native Red Spruce, and can be used for the same purposes. In Europe it is largely devoted to general construction, where not exposed to the weather, and for interior finish. It is not as heavy or as durable as the European Larch, which is there largely used for outdoor work. The bark is used in tanneries in Europe, though not heavily charged with tannin.

Norway Spruce is a moderate but frequent seed-bearer, the cones ripening the first year. The percentage of fertility in the seeds is not very high, but their abundance compensates for that. It may be grown by planting seeds, but growing plants in a nursery is largely followed in Europe. There is little difficulty in growing a supply of plants and the treatment in the nursery beds should be the same as for White Pine, and, like that, it is best to transplant them in the nursery once before setting them out in the forest, as they are rather slow growers for the first four or five years. After that, they grow vigorously, and in suitable soils as rapidly as White Pine. It will, no doubt, prove in some situations a useful companion for that tree, being one of the very few species which can be recommended or even tolerated for that purpose. They can be set out in alternate rows or alternately in each row. If no mishap comes to the Pines, the Spruces can all be removed as thinning progresses; but if anything happens to the Pines, then there will be a stand of Spruce; or they may be allowed to grow together until mature, if nothing happens to either. It is more valuable for pulp than Pine; in fact, is as useful for that purpose as our native Spruces, and it would bring a greater revenue from thinning than

if the stand were all Pine. It is the easiest of all the timber conifers to transplant, but the same care should be taken as with other evergreens to shield the roots from becoming dry. Aside from its value as a timber tree, it would, no doubt, be profitable to grow it as a Christmas tree. The first thinnings of the plantation would certainly be marketable for that purpose. It is not as liable to attacks by insects or diseases of any kind as our native evergreens, but as it starts early in the spring late frosts may destroy the leader; when that occurs it at once sets out to grow a new one by developing dormant buds which form between the whorls of each year's growth, or one or more limbs may attempt to assume that dignified position. In any event, all but one of the volunteer leaders should be promptly cut back. If that is not done, two or more stems will be the result. Gathering seeds and propagation should be along the same lines as for White Pine. Being rather more intolerant of shade than that tree, they need not be set so close in the forest.

THE FIRS

THERE are nine species of Fir in the United States, two of them east of the foothills of the Rocky Mountains, while the others belong mainly to the Pacific Slope. A distinguishing feature of the Firs is their dense, sharply conical crowns, composed of comparatively small limbs which spring out from the stem in whorls, and these develop branches on each side of the limb somewhat like vanes on the central quill of a feather. Another peculiarity is that the cones are erect on the branches, wherein they differ from the Pines and Spruces. The stem of the Fir is a true taper from the ground to the very tip of the leader, unless some accident has robbed that feature of its supremacy, in which case two or more limbs will attempt the ascendancy, each, however, assuming the same tapering form that the original one adopted. All are light-demanding, and unless crowded will retain their limbs.

THE EASTERN FIRS

THE common name given to the two Eastern Firs is "Balsam," although they are loaded down with many others, among which "She" is a prefix, an absurdity which is as far from the truth as it is from good taste, as each tree bears both staminate and pistillate flowers. Botanically one is called *Abies fraseri* and the other *Abies balsamea*, and under these names they will be considered.

Abies fraseri is confined to the Appalachian Mountains from southwestern Virginia to western North Carolina and eastern Tennessee, and at elevations above 2700 feet. It is not a large tree, seldom reaching seventy-five feet in height or a diameter of thirty inches. It is a slow grower, and thus far appears to be short-lived in cultivation, but

the attempt has been made for ornamental purposes only, and where the tree has been entirely in the open. When planted in the forest, with a suitable forest floor, it will doubtless prove as vigorous as in a virgin forest, but there is little to justify any effort at artificial cultivation, for, by proper treatment, natural reproduction can be maintained where desired.

The wood is light, soft, coarse-grained, and weak. The heartwood is pale brown and the sapwood nearly white. It is used for general construction, box boards, and pulp.

Abies balsamea. This is the common "Balsam" of the Northern States, and is confined to the states bordering on the Great Lakes, to West Virginia, Virginia, Maryland, Pennsylvania, New York, and New England. It spreads over nearly all of Canada east of the Rocky Mountains, except on the plains between Winnipeg and Calgary. It closely resembles the Fraser Fir except that it prefers moist bottom lands, and even swamps. The tree seldom reaches a height of sixty feet or a diameter of thirty inches. It is a slow grower at best, and especially so in swamps, where it may not increase an inch in diameter in twenty-five years. It may be recognized by its "blisters," which contain a clear thin pitch, commercially known as "Canada Balsam." These blisters are arranged horizontally around the tree in irregular sections and just beneath the smooth surface in the outer bark of young and middle-aged trees, and on limbs of old ones, and when pricked or cut open the limpid pitch flows out. The Indians called the tree "Blisters."

The wood is soft, light, weak, coarse-grained, and decays quickly when exposed. It is used for box boards, coarse lumber, and pulp. The heartwood is pale brown, the sapwood lighter colored, and it is seriously alleged that it is sometimes mingled with Spruce and sold as such.

Like the other Eastern species, it is short-lived when planted in the open. When planted as an ornamental tree, it frequently fails when thirty to forty years of age, yet it

is probable that planting in a close stand would make its artificial cultivation possible; but there is little reason for undertaking it. Natural regeneration will take place if opportunity is offered, and should be encouraged on ground where it will grow and where better species will not.

THE WESTERN FIRS

THE Western Firs¹ indigenous to the United States are mainly confined to the Olympic, Coast, and Cascade ranges of mountains in Washington and Oregon and the Sierra Nevada in northern California, although they extend as far east along our northern border as the western slope of the Continental Divide in Montana. Of the seven species found there, six are of sufficient economic importance as timber trees to warrant consideration, although nothing based upon experiment or experience can be said concerning their propagation. It cannot be learned that anything has been done in that line beyond what nurserymen have attempted in order to determine their fitness for ornamental purposes, the results of which, it must be confessed, have been anything but favorable for their propagation east of their natural range. Late reports show that some of them are thriving in Europe and indications are that they will do well there as forest trees. Therefore all that can be said here intelligently respecting them must relate to their locality, general characteristics, and value as timber trees. Probably not until a much greater exhaustion of all the Pacific Slope and Rocky Mountain conifers takes place will anything be done towards propagating or even protecting these valuable species of trees.

¹ Until recently little has been known in the Eastern States concerning the Firs of the Pacific Slope. This lack of knowledge has now been supplied by Mr. George B. Sudworth, dendrologist of the United States Forest Service, in a publication entitled *Forest Trees of the Pacific Slope*, issued October 1, 1908, and I am largely indebted to him for what is here said concerning the Firs of that region, — to which I have added my own observations when studying the western trees. The criticisms of manufacturers and dealers are wholly mine.

The important Western Firs are Grand Fir (*Abies grandis*), White Fir (*Abies concolor*), Amabilis Fir (*Abies amabilis*), Noble Fir (*Abies nobilis*), and Red Fir (*Abies magnifica*). The others are not worthy of consideration. (The so-called Douglas Fir, an important tree, is not really a Fir.)

GRAND FIR: *Abies grandis*

THIS tree is generally called White Fir, for the reason that its smooth bark is conspicuously white. As there is another species to which that name is commonly and more appropriately applied, — *Abies concolor*, — it is proposed by Mr. Sudworth to discard the appellation “white” and adopt that of “grand” in its place, making it Grand Fir. This is certainly a more correct designation, for it eliminates the elements of confusion and error and also gives a name suggestive of its character.

Its natural range is throughout a large portion of Washington, Oregon, and northern California, where it may be found along alluvial stream-beds, on the slopes of the mountains from near the coast up to an elevation of 7000 feet above the sea. It is also indigenous to Idaho and Montana eastwardly to the western slope of the Continental Divide. It grows to a height of two hundred and seventy-five feet, with a diameter of four feet on bottom lands, and on elevated situations from eighty to one hundred and twenty-five feet high and from eighteen to thirty inches in diameter. The stem is straight, gradually tapering, and when in dense stands clean of limb for fully one half of the total height of the tree. It is light-demanding, and if grown in the open retains its limbs from the ground up. It is a fairly good seeder, and as the seeds are not heavy and the wing is large, they can be blown a long distance.

The wood is light, soft, moderately coarse-grained, and straight, not durable when exposed, not strong, yet firm enough to be useful for interior finish, box boards, and many like purposes. In color the heartwood varies from

pale yellowish brown to pale brown, with thin lighter-colored sapwood. It is not known whether it is suitable for pulp, but it is reasonable to suppose that it is. Owing to a general prejudice against fir lumber, — a prejudice which naturally comes from its association with Sugar Pine and Western Yellow Pine, — it is not extensively cut, but will undoubtedly be favorably accepted in due time.

WHITE FIR : *Abies concolor*

No objection can be seriously urged against the name commonly applied to this tree, for the color of its wood fairly justifies it, but notwithstanding the fitness of this name, ten others have been added, among which are Bastard Pine and Black Gum. Its range is from Oregon to southern California, northern Arizona and New Mexico, to Colorado and Utah. It grows to its largest size in the coast region. It may occasionally be found there two hundred feet high with a diameter of six feet ; more commonly eighty to one hundred feet high and twenty to thirty inches in diameter. The stem is straight and tapers gradually. Mature trees are covered for some distance above the ground with rough bark from four to six inches thick and deeply furrowed. It is a rapid grower for the first fifty to one hundred years ; after that, its growth is slow until it reaches its end, which is at about three hundred years. A tree sixty inches in diameter showed three hundred and seven annual rings. While it requires less moisture in the soil than the other Firs, it still rejoices in a humid atmosphere. It is moderate in its demand for light at all periods of its growth. Only Alpine Fir and Engelmann Spruce are less so among associated species.

The wood is very light, soft, coarse-grained, not strong, but sufficiently so to be useful for ordinary purposes ; is easily worked, but is not durable. It is nearly white in color, being slightly tinged with very light brown, and is odorless, which latter feature makes it valuable for packing-

cases, especially for butter. It is not extensively manufactured at present.

It is a fairly good seeder, with a large wing attached to the seed, and the percentage of germination is good. It is not exacting as to a seed-bed, and this, with its endurance of shade, enables it to wage an aggressive and successful contest for reproduction among its associates.

AMABILIS FIR: *Abies amabilis*

JUST why "Lovely Fir," by which name this tree is largely and significantly known, could not have been allowed to remain instead of "Amabilis," both meaning substantially the same, is hard to understand. It is sometimes called White Fir, which is not truthfully suggestive; but "Amabilis" is adopted by authorities and hence must be accepted. Its range is confined mainly to the Cascade Mountains of Washington and Oregon, where it is found at an elevation of one thousand to six thousand feet above tide. Its stem is slender and straight and, in favorable locations, with a diameter of five to six feet and a height of two hundred feet; but a diameter of eighteen to thirty inches and a height of seventy-five feet are far more common than any near approach to the dimensions first named. It is moderately light-demanding, and may be found clear of limbs for fifty to eighty feet in close stands. In the open it retains its limbs from the ground up. It is a slow grower. Trees from sixteen to twenty-four inches in diameter are from one hundred and seventy-five to two hundred and thirty years old.

The wood is moderately soft, but considerably harder than that of some of the Firs, close-grained, not strong or durable when exposed; heartwood light brown, with thin, lighter colored sapwood. It can be used for interior finish and similar purposes, but at present it is seldom cut for lumber, because better wood can be secured more easily.

It is a prolific seeder, and it would seem to be capable

of perpetuating itself if given a chance, but it must be remembered that it is a slow grower and other trees may be profitably grown in its stead; this is undoubtedly true, for the area in which it is found produces faster growing ones and those yielding far better lumber. Still, it would be a misfortune to have this beautiful tree become extinct.

NOBLE FIR: *Abies nobilis*

HERE is another unfortunate confusion of names. Some Oregon lumbermen, finding a prejudice existing against lumber cut from any Fir, concluded, a score or more years ago, to conceal the true character of this tree and call the Noble Fir a Larch. The excuse for this was that if given its proper name, no one would purchase it, but if it were thought to be something else, there would be no hesitation, nor would the purchaser be wronged, for the lumber cut from this tree was as good as that cut from the Larch. If this had been true, such a course would have been open to less criticism than it now deserves, as the wrong to the purchaser would have been eliminated; but it was not true, for the Larch has some valuable qualities which the Noble Fir does not possess, among which are hardness and durability when exposed to the ground. Then others, knowing that Red Fir ranked high in quality among the Firs, concluded, for reasons of their own, to call this one Red Fir too. This confusion should cease. No suspicion of deception should be attached to manufacturer or dealer. The red man called the tree "Tuck Tuck."

The name "Noble Fir" is very appropriate and significant and should be adhered to, for there are few trees that can equal it in grandeur and nobleness of form and appearance. Its range is limited mainly to Oregon, Washington, and northern California. It may be considered a moisture-loving tree, both as to soil and atmosphere, and should not be expected to thrive outside of its natural habitat or where climatic conditions are unlike those it enjoys at home. At

its best it towers one hundred and fifty to two hundred and fifty feet with a stem six to seven feet in diameter, with slight taper, and clean of limb for one hundred feet or more. It is light-demanding, and if not grown in a dense stand will be found well clothed with limbs from near the ground up; the seedlings do not thrive in the shade.

The wood is among the heaviest of the Firs, only the Red Fir exceeding it; a seasoned cubic foot weighs twenty-eight pounds, while the Red Fir weighs twenty-nine pounds, and our eastern White Fir only twenty-two pounds. It is moderately hard and firm, strong, elastic, medium fine-grained, heartwood light brown, irregularly marked with reddish brown areas, — which add to its beauty for interior finish, — with thick and somewhat darker sapwood, — the latter feature unusual for a conifer. It is easily worked and should come into more general use, as it is superior in quality and quite different from any other Fir, and for some purposes equal to more popular coniferous woods.

It is a good seeder, but the percentage of germination is unfortunately low, and the seeds are greedily devoured by birds and squirrels, the Douglas squirrel being the greatest offender. The cones are large for a Fir, being from six to seven inches in length, and unlike those of any other species. Whoever has seen them standing upright on the topmost limbs of these giants of the woods, or has had the pleasure of close inspection, will never forget them. In their conspicuousness they vie with the unique cones of the Sugar Pine. Reproduction should be at once undertaken in some form, but just what method would be best experiment only can determine. It is true that the tree is comparatively a slow grower, and a long time must elapse before merchantable trees can be grown, but for all that, our obligations to posterity require us to do our duty and transmit such species as prove valuable in our day. The great giants will soon be gone, but we should leave it possible for others to grow.

RED FIR: *Abies magnifica*

THE name given this tree is eminently appropriate because of the deep brown-red of its bark and the tinge of red in its wood, while the botanical appellation *magnifica*, magnificent, is well bestowed. The author first saw the tree on the southern slope of Mount Shasta, and well remembers the towering, stately form, with its red stem, and can well understand why it is thought magnificent. There is another variety of this tree known as *Abies magnifica shastensis*, but the two are so nearly identical in every economic respect that a separate description would be superfluous. The range of the Red Fir is on mountain slopes and ridges, at an elevation running from four thousand to eight thousand feet above the sea, from southern Oregon and northern California southward on the Sierras.

It has been found reaching a height of one hundred and seventy-five to two hundred feet, with a stem seven or eight feet in diameter, and fully one half its length clean of limbs, but such specimens are rare. When growing in favorable locations and in dense stands, it forms a slightly tapering stem free of branches for seventy-five or eighty feet, but generally running from twenty-four to thirty-six inches in diameter. It is smallest on high elevations. It is slow-growing and long-lived, frequently reaching an age of three hundred and seventy-five years. When growing in the open, it retains its limbs from near the ground up. The bark in old trees is from two to three inches thick and deeply furrowed.

The wood is the heaviest of any of the Firs. It is soft, not strong, comparatively durable, light brown tinged with red, with thick and somewhat darker sapwood. It is firm and can be easily worked, but thus far has been mainly used for fuel, packing-boxes, and cheap construction. There is no apparent reason why it may not be far more generally used than now.

It produces seed abundantly. Its cones are conspicuously large, and as on all other Firs stand upright on the limbs and mature the first year. It cannot be learned that any effort has been made looking to reproduction, and there is not likely to be any until the more popular species of timber trees are exhausted. When that time arrives, it will dawn upon those who must have lumber that the Firs here described have a real economic value and are worth preservation. It will be the same as it is in the Eastern States with the Spruces, Hemlocks, the Red Oak class, and other species which at one time were deemed worthless, and were so in comparison with White Pine and the White Oak class, but which are now bringing prices equal to if not greater than those that the latter brought when they were the most rapidly exploited.

DOUGLAS FIR: DOUGLAS SPRUCE:

Pseudotsuga taxifolia

THIS is one of the most important timber trees west of the great Continental Divide. Only the Tideland Spruce, the Big Tree, and the Redwood exceed it in size, and none but the Western Yellow Pine (*Pinus ponderosa*) can supply so great an amount of first-class merchantable lumber. While the tree is loaded with nearly a dozen local names, the lumber trade has added to the confusion by giving several different names to the lumber cut from it. One may purchase in market Douglas Fir, Red Fir, Yellow Fir, Douglas Spruce, Yellow Spruce, and Oregon Pine, and yet all may be cut from the same identical tree. The author well remembers how he was corrected in a Los Angeles planing-mill when he called some lumber which a workman was putting into a door Douglas Spruce, and was promptly told it was Oregon Pine — and the man really thought it was Pine. It is not a Spruce, nor is it a Fir or a Pine, but it largely partakes of the characteristics of a Hemlock, hence its botanical name, *Pseudotsuga*, which means False Hemlock. Professor C. S. Sargent declares “*Pseudotsuga* is a barbarous name,” but for all that, it indicates its true character.

Its natural range in the United States is from the Canadian line south, through most of the mountain ranges, to nearly, if not quite, the Mexican border, and from the eastern base of the Rocky Mountains to the Pacific Ocean, but it is not found on the mountains of the arid region of the Great Basin. Its best development is along the coast region of Washington and Oregon near the level of the sea, and on the lower western slopes of the Cascade Range. It ascends these and the Sierra Nevada of California up to five thousand, and in some places up to six thousand or more feet above the ocean. In regions where it thrives best, trees

may be found two hundred and fifty and, occasionally, three hundred feet in height, with a diameter ranging from six to twelve feet, and it is claimed up to fifteen feet, yet in high and exposed situations it may not reach ten feet in height. The average of trees chosen for lumber is far below the great dimensions named, but seldom is a tree cut of smaller diameter than two feet. It is a strong, vigorous grower under favorable conditions, and generally dominant, suppressing all other trees which may attempt to become near neighbors. Large areas may be seen where it is in nearly pure stands and where a large number may be found to the acre. One standing in a grove of mature Douglas Fir in its best development may find his range of vision limited to a very small area by the naked stems of the trees. Aside from the Redwood, no other tree has been known to produce so great a yield to the acre. Where standing in a vigorous forest, it has a straight, slightly tapering stem, which may frequently be seen clean of limbs for two thirds of the tree's height; but it is not unusual for it to have small and inconsequential limbs along its stem towards the top.

It is quite variable in character through climatic and local conditions. Trees growing on high elevations, and especially on the eastern slopes of the Cascade and Sierra Nevada ranges and the Rocky Mountains, are inferior to those along the western slope of the Cascade and Sierra Nevada or on the Coast Range. They are not only smaller, but the lumber cut from them is not of as good a quality.

In some respects the wood resembles that of the Larches and some of the softer Yellow Pines, but with less resin than the latter. It is undoubtedly the strongest of the softwood conifers; and, weight for weight, is nearly as strong as that of the Oaks. The heartwood ranges in color from red to yellow, with nearly white sapwood, varying in thickness. It is claimed that the red and yellow are different species or, at all events, different varieties. This is undoubtedly an error. It is possible that the difference in color may arise from age, rapidity of growth, or conditions of soil and



DOUGLAS FIR

Some of the trees shown are more than seven feet in diameter. Western Washington. — *Copyrighted, 1902, by Kiser Photo. Co., Portland, Oregon.*

location; but none of these reasons can prevail when different colors are produced in the same tree, which is not uncommon. Evidently the causes which produce the discoloration are not understood. As a rule, the wood is hard and somewhat difficult to work, and, again, it is found soft and adapted to almost any use, and no insignificant competitor to Western White Pine. It is not durable when exposed to the soil, but for want of wood which is more durable it is largely used for railroad ties and telegraph poles. The tendency of large sticks to check in seasoning operates somewhat against its use in heavy structural work, but when cut into boards and plank, it seasons without checking, and is well fitted for interior finish as well as for general purposes. It serves well for masts of ships, booms for derricks, and other like uses where large, long, stiff, strong, and straight timber is required.

The bark is thin when the tree is less than about twelve inches in diameter, which makes it at this stage very susceptible to injury from forest fires; but on mature trees the bark at the base may reach a thickness of twelve or even fourteen inches, and more on very old trees, and as it does not scale off, it is then very rough with deep wide furrows. The character of the bark varies much with the humidity of the region. Trees in dry and exposed situations have rougher bark than in moist, damp forests.

If reasonable care should be taken, natural reproduction would go far towards perpetuating the supply, especially in western Oregon and Washington. But when fires are permitted to run on cut-over lands, or second growth is cut down on lands unfitted for cultivation, simply to obtain scant pasture for live stock, little need be expected in the line of conservation until exhaustion teaches a sorrowful lesson. The tree is a rapid grower for the first one hundred to one hundred and fifty years of its life, when the annual rings begin to lessen in thickness, and at the age of three hundred years they are not more than half as thick. This produces both coarse- and fine-grained wood in the same tree.

It is a prolific seeder, generally producing seed each year, with a high rate of fertility. The cones ripen early in August, and by September they open and the seeds are scattered by the winds. The seeds are about the size of White Pine with a wing of the same dimensions. They are largely eaten by birds and squirrels, but the great number produce leaves enough for abundant reproduction. Experiments in eastern nurseries show that the production of young plants is not at all difficult. The tree grows quite rapidly in the East at first, but almost invariably fails as age creeps on. Experience in attempts to grow it east of the Mississippi River has not been encouraging, although it is said to do well in Europe. It is possible that seed gathered from trees growing on the eastern slopes of the Rocky Mountains may produce trees that will endure the climatic conditions which must be met in the East. It is reported that it does very well in Iowa and Minnesota. In western North Carolina it made in ten years less than half the height of White Pine of the same age and planted by its side. Whether it can be best grown by planting seeds where the trees are to stand, or whether trees would best be grown in a nursery must be determined by experiment, but it is very probable that seed planting will serve as well, and it would certainly be much less expensive. Experiments in that line should certainly be made by those who may live within the bounds of its natural range.

THE HEMLOCKS

THERE are three species of Hemlocks indigenous to the United States, which have had, and, to a certain extent, still have, an economic value as timber trees. Two of them — known as Eastern Hemlock — are scattered over a large portion of the country east of the Mississippi River, and the home of the other is west of the Continental Divide, where it is confined mainly to the states of Washington, Oregon, and California. The technical appellation for the species is *Tsuga*, which is the Japanese name for Hemlock; and just why such a strange and barbarous word from a far-away country should have been selected for a tree so widely spread over our continent is hard to determine. The Indian name, Oh-neh-tah (“Greens on the Stick”), is no less civilized and quite as euphonious; but the foreign technical monstrosity has “come to stay.”

In general characteristics the Hemlocks much resemble the Spruces, taking on a pyramidal form without specialized branches, with short leaves and pendant but small cones. Their limbs do not, however, spring out from the stem in whorls, as do most of the conifers, but grow at irregular intervals from each other. Their leaves remain on the branches from three to six or seven years. All have straight, slightly tapering stems which are covered with rough, hard, and somewhat rigid bark of a reddish cinnamon color when broken, and which contains much tannin. This last feature has made the tree of much more commercial importance in the East than it would have been for its lumber alone, and large quantities were cut there in former days for the bark only, the wood being left to rot on the ground or be consumed in forest fires, which were rather encouraged than otherwise. No other tree of moment has bark so highly charged with tannin, not even the Chestnut

Oak (*Quercus prinus*), and the Pacific Coast species contains more than the Eastern ones do.

EASTERN HEMLOCK

THE two Eastern species are respectively named "Hemlock" (*Tsuga canadensis*) and "Carolina Hemlock" (*Tsuga caroliniana*). In spite of the name of *canadensis* for the northern one, it is no more common in Canada than in the United States, nor as much so. Doubtless the states of Maine and Pennsylvania once possessed as much as all Canada, to say nothing of what grew in other states.

There is little need of an elaborate or extended description of either of the Eastern species, — they are substantially alike — or to designate the best methods of reproduction, for as timber trees they are practically doomed to extinction. While the lumber produced from them is not of a high grade when compared with the Spruces and Pines, yet the growing scarcity of these has caused Hemlock to become better and more favorably known, and for the last thirty-five or forty years vast quantities of it have been consumed for many purposes, latterly bringing high prices. Added to its use as a timber tree is the value of its bark, for tanning, and the further use for the wood for pulp, — it ranking next to Spruce for that purpose, — and all conspire to hasten the day of its departure. They are slow growers and the most difficult of all the coniferous timber trees to transplant successfully. Like all others it must be grown in dense stands to compel it to drop its limbs, and where so grown it is very sensitive to any interference by man. Old lumbermen well understand that fact. Even cutting down a few trees among them will cause the death of near neighbors.

The wood of the Eastern Hemlocks is hard, much given to "wind shakes," is generally cross-grained, splits easily, warps when seasoning, and much of it is filled with large knots which are so hard as to break any but the best of



VIRGIN STAND OF WHITE PINE AND HEMLOCK, WITH
SECOND GROWTH OF EACH COMING ON WHERE
ORIGINAL FOREST WAS CUT OFF

Clearfield County, Pennsylvania.



VIRGIN STAND OF HEMLOCK, FROM ONE HUNDRED AND FIFTY TO
TWO HUNDRED YEARS OLD

Tioga County, Pennsylvania. — *Photographed by George Harrison.*

steel implements used in cutting and working it. Now, add to all this the further fact that natural reforestation can stand no chance whatever with seed trees gone, and that in nearly every situation in which it thrives better species, such as the Pines, will grow more rapidly and produce more and better lumber, and it can be readily seen that efforts to cultivate the tree for timber would not be advisable. As a timber tree it must hereafter be relegated to areas where it can, with a scant number of seed trees, maintain itself by natural reproduction, coupled with adverse surroundings. It is a slow grower in early life as well as in old age, and quite a prolific seeder.

As an ornamental tree it has no equal among the coniferous evergreens. The late A. J. Downing, the father of landscape gardening in America, pronounced it the most picturesque and beautiful of all the evergreens in the world, and he was undoubtedly correct. In the open, its crown grows a dense cone with limbs from the ground up, its terminal sprays drooping gracefully and in early summer tipped with the new yellow leaves, which show like blossoms all over the tree, the dark background of leaves of former years' growth furnishing a harmonious but contrasting setting. As it grows old, the lower limbs begin to die, although the tree is quite tolerant of shade. It has been a valuable tree and is to-day, but when the question of reproduction is to be determined, it must give way to better species and those that can be much more easily and profitably propagated.

WESTERN HEMLOCK

THE Western species is commonly called "Hemlock," and its botanical designation is *Tsuga heterophylla*. Its range is along the Canadian line from the Pacific Coast east to Montana and south along the Cascade Mountains to northern California, at elevations varying from close to sea level to five thousand feet above. Its best development is in western Washington and Oregon, where it attains a height

of one hundred and fifty feet, with a diameter of five or six feet, yet such specimens are rare. It thrives best in a moist soil and a humid atmosphere. It is rather more light-demanding than its Eastern relatives and in dense stands will grow tall, with a slightly tapering stem clean of limbs for half its height. It is superior in all respects to any other Hemlock as a timber tree. The bark is more valuable, and the lumber cut from it is of such good quality that the lumbermen of Washington and Oregon have little or no difficulty in mixing ten per cent of it with Douglas Spruce and palming it off on customers and consumers for "Oregon Pine." The wood is fine-grained, rather light, soft, tough, and more durable than the Eastern species. The heartwood is pale yellowish brown, slightly tinged with red, with thin and nearly white sapwood. Except in point of strength the one who purchases Western Hemlock believing it to be "Oregon Pine" is not much wronged, for it is softer and more easily worked than that wood; in fact, is nearly equal to the Western Yellow Pine in facility and ease of working. If the purchasing public could be induced to lay aside the prejudice which loads down the very name of Hemlock, and to accept the lumber cut from this particular species, and to accept it on its merits, it would quickly come into general use, for it is really a valuable wood. It has few of the defects of its Eastern relative.

It is a very prolific seeder and will reproduce itself if given anything near a fair opportunity. No other method need be undertaken if sufficient seed trees are left and fire kept out. It is not known that any attempts have been made to propagate it artificially, except such efforts as have been made by eastern nurserymen who have endeavored to grow it as an ornamental tree, but with poor success. It has been developed in the moist climate of the Pacific Coast and cannot endure removal, although it is stated that it thrives fairly well in northern Europe not far from the sea. Unfortunately it is a slow grower, and trees sixteen or seventeen inches in diameter are from three hundred to four hundred years old.

RED CEDAR: *Juniperus virginiana*

No matter what may be said of the inaccuracy in calling certain different species of trees "Cedars," that name is so fixed in the lumber trade and in the mind of the public that submission is the only alternative. The species so misnamed are the Junipers, Thuyas (*Arborvitæ*), *Libocedrus*, and *Chamæcyparis*, but in the common parlance they are all "Cedars."

The Junipers are, no doubt, the most widely distributed species of trees on our continent and may be found in nearly every state of the Union. Except for posts and like uses, and in some sections, for fuel, only one of the eleven species of Junipers in the United States has any commercial value as a timber tree, and that is the one commonly called Red Cedar, botanically known as *Juniperus virginiana*. It may be found growing but little better than a shrub in some sections, and as a stately tree one hundred feet high and three or four feet in diameter in others. Ordinarily, where cut for lumber it does not reach more than fifty feet in height and twelve to fifteen inches through. While its size is materially affected by soil and location, it will persist in accepting, with a compensating discount, almost any soil or location from a swamp to a rocky cliff. Its range is from Maine to Florida and westward along the Canadian line to North Dakota, and southward to Texas. Its best development is south of the Ohio River. Along the foothills of the Cumberland Mountains, in the valley of the Tennessee River, and in northern Alabama, there could once be seen vigorous stands of large trees, but they are now sadly thinned. It generally grows mixed with other species, but on the so-called "Cedar Barrens" of middle Tennessee it forms pure stands.

It is an evergreen conifer and in early life, when in the

open, sends up a straight stem covered from bottom to top with small short branches, forming a narrow-based, slim, sharp cone for a crown; but as age creeps on, its lower limbs die or cease to grow and the crown assumes a round and irregular form. It is a slow grower at all periods of life. One on the author's lawn has a stem three and one half inches in diameter, one foot above ground, outside the bark, and is fourteen feet high and fully twenty years of age. A board in his possession, showing nearly the full diameter of a tree, which was fourteen inches, has an average of twenty annual rings to the inch for the first six inches of its growth and an average of thirty-five for the remainder. The tree was not less than one hundred and ninety years of age. It will not be safe to count on saw timber in less than one hundred and fifty years from the time of planting.

The wood is light, soft, easily worked, close-grained, quite brittle, not strong, and very fragrant. The heartwood is a dull red, with thin and nearly white sapwood. There is a plain but not prominent distinction between spring and summer growth both in color and hardness, as any one sharpening a lead pencil will have observed. The medullary rays are numerous, small, and hardly visible to the naked eye. It is largely used for posts and for sills of buildings and other places where great durability is desired, the sapwood, however, decaying much sooner than the heartwood. The heartwood is extensively used for lead pencils, — no other wood proving so acceptable, — interior finish, closets and chests to exclude moths, and for pails, tubs, and other household utensils.

It is a good seeder and the seeds are widely scattered by birds, but germination is slow and difficult to bring about in the nursery, and seedlings sometimes suffer seriously from a fungus disease. There is considerable difficulty attending growing seedlings to an age suitable to transplant into the forest. Any one contemplating it to even a moderate extent should consult *United States Forest Service*

Circular No. 73, entitled "Red Cedar," where full and explicit directions for gathering, caring for, and planting seeds will be found, together with instructions for setting the plants into the forest. Those who require a limited number will do best to obtain them from some nursery or secure them where natural reproduction has taken place. It should be remembered that drying the roots by exposure to the air is almost certain to prove fatal.

While it is a very valuable wood, the fact should not be overlooked that many other species of trees will grow rapidly and can be successfully planted where Red Cedar thrives best, and will bring returns far sooner and are less liable to disease. Had we the patience of the German we should plant the tree for future generations, just as he did nearly fourscore years ago, seeing that it would be needed for "pencil wood" in due time, and the time will come much sooner than he anticipated.

WHITE CEDAR: ARBORVITÆ: *Thuya occidentalis*

THERE are two species of Arborvitæ in the United States. One is in the East and is commonly called White Cedar (*Thuya occidentalis*), and the other belongs to the Pacific Slope and is generally known as "Cedar," but is sometimes called Red Cedar. Its botanical appellation is *Thuya plicata*. Both species are resinous, aromatic, coniferous evergreens, the Eastern one of moderate dimensions and the Western one of gigantic proportions. Neither is a true Cedar, but both are classed as such by the lumber trade.

The Eastern tree is almost universally called White Cedar. It is not loaded down with many names. The Indians called it "Oo-soo-ha-tah," — Feather Leaf, — which really sounds as well, or better, than "Thuya," a name which can be applied to other coniferous trees. It is found in dense stands on swampy ground bordering the banks of streams and shores of lakes — occasionally climbing to drier ground — along the northern boundary of the United States from Maine to the Red River of the North, and south to central Minnesota and Michigan, northern Illinois, and in the Atlantic region along the mountains to North Carolina and also reaching eastern Tennessee. In its northern range trees fifty to eighty feet high, and with a buttressed base of four feet, were frequently found. But few such trees are left, yet white cedar telegraph and telephone poles may still be seen quite two feet in diameter and forty or fifty feet in height cut from the forests of northern United States or Canada.

Its tendency is to grow tall whether in the open or in a dense stand. If crowded, that tendency is intensified and the lower limbs die and drop off, leaving a comparatively clean stem for a considerable height, with only small

branches composing the crown. When growing in the open borders of streams or lakes, its persistent demand for light causes many trees to grow crooked, bending outward in early life and then turning upward, thus rendering the tree unfit for anything but short stuff.

The wood is very light, a cubic foot weighing only nineteen pounds when dry. It is soft, straight-grained, easily split, weak, brittle, moderately fine-grained, durable when exposed to the soil, and fragrant. The heartwood is pale yellowish brown, with thin and nearly white sapwood. There is little difference between spring and summer growth. It is largely used for posts of all kinds, telegraph, telephone, trolley and electric-light poles, railroad ties, hop poles, shingles, boats, and sills for buildings. Notwithstanding that the wood is very durable, many live trees above nine or ten inches in diameter will be found hollow for a few feet above the ground. This decay appears to cease after the tree is cut.

It is a prolific seeder and natural reproduction will take place fairly well, if permitted. It can be readily grown in the nursery, and its shallow, fibrous root system renders it an easy tree to transplant. It is a slow grower, but as it thrives best where more rapidly growing trees do not, and as it is almost indispensable for certain purposes, its propagation should be undertaken where the location is suitable and where more valuable species will not grow equally as well. While it will grow on comparatively dry ground, it does not thrive as well there as in its natural soil.

The seeds mature in one year and should be gathered from the 1st to the 15th of September. They are very small — running from one hundred and fifty thousand to one hundred and seventy-five thousand to the pound — and almost entirely surrounded with a film-like wing, and are readily blown a great distance. The treatment of seeds, propagation in the nursery, — transplants are preferable, — and subsequent removal to the forest should be the same as for White Pine except that they should be set closer in the

forest than is advisable for that tree: from four to five feet apart would be about right in most situations. If transplants are not sought, the seedlings may remain in the seed-bed for three years, as the tree is a slow grower in early as well as in later life. If at all encouraged, natural seeding will take place, and no doubt planting seeds would be successful. No information can be obtained of any effort to grow it as a forest tree, but it is largely used as an ornamental tree and for wind-breaks.

There is another tree commonly called White Cedar, but which is botanically known as *Chamaecyparis thyoides*. It closely resembles the Eastern White Cedar just described, but grows to greater dimensions, frequently reaching a diameter of four feet above a slightly buttressed base, and a height of seventy-five or eighty feet. It may truthfully be called a coastal tree, as it is mainly found in swamps that are sometimes submerged for months, along the coast from Massachusetts Bay to the Gulf of Mexico, rarely reaching farther west than Mobile Bay. It is better adapted to the manufacture of lumber than the Eastern Arborvitæ, as the stem is more cylindrical and its taper much less; but the lumber trade makes no distinction. The character of the wood and its uses are substantially the same, although there is a greater difference between spring and summer wood, and the annual rings are consequently more conspicuous than in the Eastern White Cedar. Whether it can be grown outside of its natural habitat is somewhat doubtful, as it is distinctively a swamp tree, yet it is possible that, like the Bald Cypress, it will grow in drier locations. If so its cultivation could become possible elsewhere.

WESTERN RED CEDAR: GIANT ARBOR- VITÆ: *Thuja plicata*

THIS species is known in the lumber trade as Western Red Cedar, or just plain "Cedar"; and, like nearly all the timber trees of the Pacific Slope, is a giant in comparison with trees in other parts of the world, though it cannot be so classed among its neighbors. It is found from one hundred and fifty to two hundred feet in height, with a diameter of ten feet at the base. The stem assumes a distinctively conical form, and in old trees the diameter at the base may be nearly twice that twenty-five or thirty feet above. The thickness of the annual rings of nearly all trees is greater at the base than above at the same age, but this is strikingly so with this tree. Another peculiarity of the tree is the deep fluting of its stem prevalent from middle age on. When young, and growing in the open, the slender limbs shoot upward, but as age increases they gradually droop, and at middle height stand out nearly horizontal, with their ends gracefully curving upward, while the ends of those lower down will rest on the ground. The limbs are never large, and the tree being tolerant of shade, they are prone to adhere to the stem until the tree reaches middle life or later. It is not infrequent, however, to see a clean stem for sixty to eighty or more feet. On old trees, in dense stands, the crown is short and somewhat rounded. Its live bark is tough, stringy, and fibrous, and is sometimes woven into coarse fabrics and made into baskets by the Indians. It lives to a great age. It is a fairly rapid grower in early life, but trees from twenty-four to forty inches in diameter run from two hundred to five hundred and ten years of age.

Its natural range in the United States — it reaches along the Pacific Slope to Alaska — is from the Canadian line

southward through Washington, Idaho, Oregon, and into northwest California, with scattered stands in northern Montana. Its best development is where the air is moist, but not next to the ocean. It prefers a fertile soil, but will thrive fairly well on comparatively dry ground.

The wood is very light, fragrant, dull and light reddish brown in color, but fading on exposure, with straight grain, varying from fine to medium, coarse, brittle, soft, easily split, and very durable. It is largely used for shingles — nearly sixty-five per cent of the shingles manufactured in the United States being from that wood — and for railroad ties, poles of all kinds, posts, sills, and every purpose where a soft, not strong, but durable wood is required.

The tree is a free seeder with a high percentage of germination, and if allowed, natural reproduction would occur. No information can be obtained as to whether any effort has been made to propagate it beyond what nurserymen have undertaken in the East, where it has not shown itself able to endure the climatic conditions. No doubt planting in the nursery and removing to the forest would succeed, but natural reproduction would be ample if allowed.

BALD CYPRESS: *Taxodium distichum*

WHY names widely different in meaning should be used to designate what may be fancied as particular characteristics of a tree, such as black, white, and red, as is the case with the Bald Cypress, is certainly very strange; but it emphasizes the difficulty of indicating what tree is meant when only the local common name is given. None of the conflicting terms named in this case, however, are used to any great extent, and Bald Cypress — probably because of its deciduous habit, becoming “bald” in winter — may be considered as the accepted name. Lumber cut from the tree is known as “cypress” in the trade. While there are two species of Cypress on this continent, and several varieties of one of them, only the one under consideration has any commercial value.

The tree is strictly a conifer, but not an evergreen, for it sheds all of its leaves and some of its smallest twigs each year. It matures its fruit in one year, but its flower buds are formed the year previous. It is mainly confined to the South Atlantic and Gulf regions, where it was once found abundantly in swamps and along low banks of streams which are usually submerged for months at a time, and in the case of some swamps continually so. Large areas, denominated “cypress swamps,” are still to be seen, where lumbering operations are difficult and expensive. It is also found growing in wet depressions and occasionally on dry ground, in Louisiana, Arkansas, Tennessee, Missouri, Kentucky, southern Illinois, and southern Indiana. It is one of the very few species of trees that will accommodate itself to extremes of moisture in the soil. Its preferred habitat is evidently in swamps where its roots are kept wet or continually submerged; yet when located on dry ground it grows nearly if not quite as well as when in a swamp

and produces apparently as good lumber. The illustration shows a tree standing on a dry knoll in the capitol grounds at Harrisburg, Pennsylvania. The base of this knoll is rock, and it is covered with alluvial gravel and sand, some twenty feet, or thereabout, in thickness. The surface of the ground where the tree stands is fully seventy-five feet above the water in the Susquehanna River, about one third of a mile distant. The tree is eighty-four feet high and twenty-nine inches in diameter five feet above the ground. It is probably about seventy-five years of age. It cannot be much, if any, above that age, as it was set out there some sixty-five or seventy years ago.

It will be observed that the natural tendency of the tree is to grow straight and tall, even in the open, where it assumes a conical form of crown with an acute apex; but in old age, and after it has attained its height growth, the limbs spread out and form a round top with a broad base, and it is then anything but the symmetrical cone shown in the illustration. When growing in swamps, it has a broad buttressed stem base, which is usually hollow, and its roots throw up smooth conical projections, termed "knees," but the extreme form or development of base largely disappears, and the knees entirely so, when growing on dry ground. What purpose these knees serve in the economy of the tree, or what functions they perform, is entirely conjectural — possibly to supply air to the roots.

It sometimes grows to a height of one hundred and fifty feet, with a diameter of five or six feet at the height where the buttressed base vanishes. These are unusual dimensions, however. We have no other valuable timber tree which so greatly modifies its method and form of growth by change of soil and location, or takes on a form in old age so widely differing from that of its youth, as the Bald Cypress. It is quite a rapid grower in early life, but generally slow in its old age, frequently not then increasing in diameter more than two inches in thirty or forty years, while in early life it may increase more than five times



BALD CYPRESS, NOT OVER SEVENTY-FIVE YEARS OLD; TWENTY-
NINE INCHES IN DIAMETER SIX FEET ABOVE THE
GROUND, AND EIGHTY-FOUR FEET HIGH

Note straight stem and freedom from large limbs and total absence of "knees."
Stands on State Capitol Grounds, Harrisburg, Pennsylvania.

that amount. The one shown in the illustration has exceeded that.

The wood is generally straight-grained, — but not always, — light, soft, easily worked, not strong, and very durable when exposed. The heartwood is from light to dark brown in color, — frequently with dark streaks, — with light-colored sapwood. The medullary rays are very small and indistinct. There is frequently a marked difference in color between spring and summer wood. It is used for general construction, interior finish, greenhouse and hotbed sash, cooperage, shingles, fence posts, railroad ties, and any purpose where light, durable wood is required. It takes paint and glue well, but does not give a fine finish when varnished, showing a dull, dark, monotonous surface. A fungus disease pits much of the wood, but as in the case of a similar disease in the White Cedar, it stops when the trees are felled. Thus far it has been artificially grown entirely for ornamental purposes, and nurserymen find little difficulty in propagating it. Being a swamp tree, ground that can be kept moist should be chosen for a seed-bed. Treatment in the nursery should be the same as for White Pine. The cones should be gathered as soon as ripe, for they fall apart soon thereafter. It is not a prolific seeder.

As its natural tendency is to grow tall when in the open, probably planting eight by eight feet apart in the forest would be close enough ; but the distance should be regulated by the character of the soil. If rich and moist nine by nine feet, or even ten by ten, might do well. Everything done in planting this tree in the forests will necessarily be experimental, and therefore should be carefully conducted and on a limited scale. As it is indigenous to this country only, and no efforts have been put forth anywhere to grow it as a forest tree, all work in that line will necessarily be without a precedent. About all we know to a certainty concerning its cultivation is that plants can be grown in a nursery and transplanted into quite dry ground and thrive well, and it will surely be safe to presume that they can be set

out on wet ground and flourish there, for such is evidently its preferred location. Its rapidity of growth in early life and the excellent character of the wood will certainly justify efforts to propagate it in the forests.¹ As it is practically a southern tree, it cannot be expected to stand extreme cold. Probably it will not thrive far north of Pennsylvania.

¹ "This tree deserves more attention from those who are cultivating forest trees than it has ever received. It is a very hardy tree in my grounds, and grows quite rapidly, even in a dry soil." — Andrew S. Fuller, in *Practical Forestry*, page 249. Orange Judd & Co., 1903.

THE LARCHES

THERE are three species of Larches (botanically *Larix*) indigenous to the United States, and two of them are of économic importance. One is mainly confined to the northern portion of the Eastern States and the other to the northern portion of the Rocky Mountain and Pacific Slope region. The Eastern species is generally known as "Tamarack," and the Western one as "Larch." The lumber trade has adopted these names, and, to avoid confusion, they are here accepted.

TAMARACK: *Larix laricina*

TAMARACK may be occasionally found in the territory lying between Virginia on the south and Canada on the north, and from western Minnesota on the west to Maine on the east. In the southern portion of its range it is seldom found as a forest tree elsewhere than in swamps, or on quite wet ground bordering swamps and sluggish streams, at a high elevation. Further north it accepts comparatively dry soil, and grows as rapidly as it does in its southern habitat on wet or swampy ground; but for all that, it is essentially a swamp tree. It is not a rapid grower at its best, even in its most preferred location, and never attains a large size, rarely reaching eighty feet in height or twenty inches in diameter; ordinarily not exceeding sixty feet in height or twelve inches through. It grows to a larger size in Canada than in the United States, as it is substantially a cold-climate tree. In the forest its tendency is to grow tall and slim with a true taper of stem from base to crown, if mishap does not occur to its leader, but if that does happen, there is a struggle set up for supremacy and two or more stems will be the result.

It is light-demanding, and in the forest is surmounted by a narrow, sharply pyramidal crown, but in the open the crown frequently becomes broken and irregular. Crowding results in killing off its lower limbs in early life, giving a smooth, clean stem, free of large knots. In swamps it develops fine, strong, and very long fibrous roots. The Indians used these to sew together the birch bark strips of their canoes, for which purpose it served admirably. The red man called the tree "Hackmatack," a name by which it is known in many places. While it is strictly a conifer, it is not an evergreen, as it sheds all of its leaves in early fall. The leaves are bright green until late summer, when they turn a pale yellow. It is not a very frequent nor an abundant seed-bearer. The little cones are usually about three fourths of an inch long and fall the second year. The seed matures the first year and is scarcely an eighth of an inch long, with a wing fully three times its length. The wood is heavy for what is really a softwood conifer, hard, strong, and very durable when exposed, or in contact with the soil. The heartwood is light brown in color, with lighter colored sapwood. Its annual rings are fairly distinct, but there is not much difference between spring and summer wood. It is used mainly for railroad ties, telegraph and telephone poles, fence posts, and other purposes where durable timber in contact with the ground is required. The "instep bend" of the larger roots is much used in light boat-building.

Growing plants in the nursery and transplanting them into such situations as their nature demands would undoubtedly be successful, but to plant them on low elevations or in dry ground in its southern range would not be likely to bring forth satisfactory results. Commercial nurserymen have no difficulty in growing them for ornamental purposes, but if reasonable care should be taken, natural reforestation would occur on ground where other and more valuable trees will not flourish. Gathering and planting seeds could fill in vacant places in swamps, and as the wood is valuable for many purposes such a course might be advantageous.

A winged insect, commonly known as a "saw-fly," has recently attacked the Tamarack in the northern portions of its range and is doing much damage, in many cases destroying large numbers of trees. There is no known remedy.

WESTERN LARCH: *Larix occidentalis*

IN this we have a tree of much more economic importance than the Eastern species, notwithstanding its comparatively restricted area. Its natural range is on the western slope of the Rocky Mountains and the eastern slopes of the Cascade Range, and from northern Montana, Idaho, and Washington as far south as southern Oregon. It is said to be in varying abundance over much of the forested area of Oregon. In its natural domain it is able to adapt itself to varying situations, running from moist, low, and even wet ground up to dry hill- and mountain-sides. As far as known, it has absolutely failed to encourage any belief that its cultivation may prove a success anywhere in the United States outside of its chosen habitat, although it is reported as doing well in Europe. It attains a magnificent growth, however, on the dry mountain slopes of its natural home. It is seldom found less than two thousand or more than seven thousand feet from sea level.

The tree frequently reaches a height of over two hundred feet, with a diameter of six or seven feet in moist ground, but on dry mountain-sides it seldom reaches those figures. Unfortunately the tree is of slow growth. The leaves closely resemble those of the Eastern Tamarack, though a trifle longer, and are shed annually. While the bark of the Eastern Tamarack is thin, that on old Western trees is frequently six inches thick from the base to twenty or thirty feet above the ground. Like nearly all conifers, it is light-demanding, and when grown crowded, sends up a slightly tapering, straight stem, free of limbs to a height, occasionally, of one hundred feet, with a narrow, short, pyramidal crown running to a sharp point. It is

long-lived, sometimes reaching the age of five hundred years. Trees from sixteen to twenty inches in diameter are from two hundred and fifty to three hundred years old.

The heartwood is heavy and exceedingly hard for a conifer. It is compact, strong, with close, satiny grain, of a light red color, with thin and nearly white sapwood, and durable when exposed to the weather or in contact with the ground. The difference between spring and summer wood is distinct both in color and hardness. It is used for general construction and especially for interior finish and cabinet-work, where its red color, and the readiness with which it takes on a fine finish, make it a great favorite with the joiner and cabinetmaker.

It is a prolific seed-bearer, but not always regular. The cones are from one to one and one fourth inches long, with a needle-like termination to the bracts which lie between the scales, and in this feature they slightly resemble those of the Douglas Fir. The seeds are small, with a thin, frail wing about twice as large as the seed. They have a high rate of fertility, but abundant moisture is required for both germination and the growth of seedlings.

Whether any attempt has been made to propagate it in its natural habitat is not known. Nurserymen in the East have failed to secure good results in attempts to grow it. It is a slow grower, and should seedlings be successfully grown in the nursery, transplanting them into the soil of a mountain-side would be fraught with uncertainty. Quite likely seed planting where the trees are to stand would be best. Experiment alone can determine what course must be pursued to aid Nature in propagating it. The value of the tree for economic purposes, notwithstanding its slow growth, should stimulate efforts to reproduce it in some way, as it grows where but few species as valuable can grow. Its thick bark must serve to protect the old trees from fire, and if fire should kill the younger growth there would still be seed trees left, unless the lumberman's axe should prevent.

EUROPEAN LARCH: *Larix europæa*

THIS deciduous and foreign conifer is quite similar in general appearance to our native Eastern Tamarack (*Larix laricina*), but is unlike it in choice of soils. Its natural home is in central and northern Europe. It is abundant in the mountain regions of France, Germany, and Switzerland, but is probably most extensively planted in the western portion of the Austrian Empire. It thrives best there on the lower mountain slopes, and delights in a moderately fertile and well-drained soil, but will grow fairly well on a poor one if not too decidedly sterile. It is a deep-rooted tree and cannot stand much moisture in the subsoil. It will start vigorously in such soils, but soon fails. In all this it is the direct opposite of our Eastern Larch, but somewhat resembles the Western one.

At home in the forest it develops into a tall, straight, and somewhat tapering stem, clean of limbs for one half or more of its height. It is not unusual for it to reach a diameter of three feet and a height of ninety to one hundred feet. In the open it takes on a distinctly pyramidal form, with its lower limbs resting on the ground, and running to a sharp apex at the top. In this it closely resembles the Spruces and Firs. It is light-demanding in the extreme and appears to prefer other species for its near neighbors, and it is claimed that it is never found in pure stands in naturally planted forests. It is a rapid grower and in this excels nearly, if not quite, all other high-grade conifers, especially on dry soils. Probably no other tree except the Chestnut and Catalpa will produce fence posts and telegraph and other poles to carry electric wires of so great durability and so soon as will the European Larch in favorable locations. Dr. Hugh P. Baker¹ states: "There are several groves in Iowa planted from twenty to thirty years ago from which telephone poles are being sold at from \$1.00 to \$1.15

¹ Iowa State College Bulletin, No. 90.

per pole, and a Larch grove on the campus, planted in 1873, with one hundred and ninety-five trees in one block, shows an average of forty-seven feet in height and a diameter of seven inches."

The wood is heavy, strong, and very durable in contact with the ground. In its home the wood is flexible, close-grained, and of considerable strength, but it is said to be brittle when grown on the rich prairie soils of our Western States. When grown on moist, fertile soil the heartwood is yellowish white, with nearly white sapwood, but the heartwood is a reddish brown and much harder when grown on less fertile and higher ground. It is largely used for general construction, poles of all kinds, railroad ties, ship-building, and all other purposes where moderate strength or long exemption from decay is desired.

The tree is a fairly good seeder, but does not produce seeds in early life. The seeds are in small upright cones and mature the first year. At present seeds must be secured from abroad, for few trees in this country are old enough to produce them. There is no difficulty in propagation. The same treatment should prevail as with White Pine. The seed does not appear to have a high percentage of fertility. A production of 20,000 to 25,000 plants to a pound of seed containing quite 70,000 seems to be about the average.

Seedlings may be transplanted into the forest when two years old, but had better be given another year in the nursery. As they are endowed with a fairly good fibrous root system, transplanting in the nursery is not so essential as with some conifers, although such treatment would give the trees greater strength to overcome their foes in the forest, notwithstanding that they make a more rapid growth in early life than most of the conifers.

We have much to learn about growing this tree in our forests, and any opinion which may now be ventured is liable to error. This much we know about it in its natural habitat: it does not submit to very close planting, nor does

it appear to thrive well in pure stands. Just how far apart to plant the trees in the forest and just what trees to mix with them must be determined by experience yet to be enjoyed. Probably White Pine, or perhaps Norway Spruce, as in Europe, may do well to mix with them. Or, if broad-leaf trees be chosen, White Ash, Tulip-tree, or White Elm may do. However, as the tree is deciduous, it would seem best to plant evergreens with it, to keep the forest floor shaded in winter. As it starts growth very early in the spring, transplanting should take place as soon as the frost is out of the ground, and it might be well to heel the plants in as soon as they can be removed in the spring.

The tree sometimes suffers in Europe from attacks of insects and a fungus disease. The latter frequently plays havoc, as it is practically uncontrollable. Thus far little damage has come to plantations in this country from either source. Taken altogether, the tree is one of much promise, and thorough and careful efforts should be put forth to determine how far we can go towards making it as useful here as it is in its natural home.

THE SEQUOIAS

THERE are two species of Sequoias, both of which are indigenous to the Pacific Slope. One is the Big Tree (*Sequoia washingtoniana*), and the other the Redwood (*Sequoia sempervirens*). They are the only remaining ones of several species which have come down to us from the days when mammals first appeared on the earth. Their existence in olden times is shown by their remains, which are to be found in the rocks of the Tertiary and Cretaceous periods. Then, as now, they grew in a warm and, doubtless, moist climate, but the domain in which they then grew now lies near, and in part within, the Arctic Circle. They and the Bald Cypress are distant relatives. They are among the tallest and are the most massive trees in the world; and some of them, still in life and vigorous, are among the oldest if not the very oldest living things. They are confined by climatic conditions to a limited area, and efforts to grow them elsewhere in the United States have not proved successful; yet they appear to thrive well in some parts of Europe, and our inability to enlarge the area in which they will grow should stimulate a determination that they shall not be sacrificed to a greed of gain, or be the victims of a spirit of vandalism.

BIG TREE: *Sequoia washingtoniana*

THERE has been some dispute over the technical name which this tree should bear, but the weight of evidence is with *Sequoia washingtoniana* as against *Sequoia wellingtonia*, and it is in entire harmony with patriotic sentiment. Its natural range is confined to California, and is there limited to the west side of the Sierra from the southern part of Placer County to Tulare County, at an elevation ranging



BIG TREES, WITH SUGAR PINE, WESTERN YELLOW PINE, AND
WHITE FIR. SIERRA NEVADA, CALIFORNIA
Courtesy of U. S. Forest Service.

from five thousand to eight thousand feet above the sea. While growing largely in groves, it is found scattered among other species. The total area in which it grows comprises about fifty square-miles, and as it is probably limited to this region, it can cut but a small figure as a lumber-producing tree. Many of the giants now standing — and which, if permitted, would live for several thousand years — will undoubtedly be cut, notwithstanding the fact that only from twenty-five to thirty per cent of the contents of the average tree is secured, owing to breakage in falling, failure to take what may be deemed of inferior quality, high stumps, and loss through splitting logs to reduce them to a size that can be sawed into lumber. Add to this the destruction by fire or changed surroundings of practically all young growth on the area cut over, and the danger of extinction is apparent. It is gratifying to note that the United States Government has secured some of the best groves, which have been placed beyond the reach of vandals, and it is devoutly wished that more will be secured.

Their dimensions are enormous. The largest trees are from two hundred and fifty to three hundred and thirty feet high and from twenty to twenty-seven feet in diameter next above the swelled base. Old trees are clear of branches from eighty to one hundred and twenty-five feet or more. They are long-lived, reaching an age of three thousand to four thousand years, and possibly more.

The wood is a brilliant rose-purple red in color when first cut, changing later to a dull purplish brown. It is very light, brittle, soft, varying in grain, during the first four hundred or five hundred years' growth, from coarse to very fine as the tree approaches old age. Containing a large amount of tannin, the wood is very durable. It is used for general construction, shingles, siding, and almost all purposes to which a soft, durable wood can be put, but it is largely sold in the market as Redwood, and it must be admitted that the purchaser is not wronged.

It is a prolific seeder, and if permitted would reproduce

itself without aid; or it can be aided by planting seeds or growing trees in a nursery and transplanting them into the forest in their natural habitat. Probably no effort will be made to restore it where cut off unless the task is undertaken by the United States Government or the State of California. It is not known what, if anything, has been done in that line.

REDWOOD: *Sequoia sempervirens*

HERE is another mighty giant of the forest. While it does not grow to as great a diameter as the Big Tree it excels it in height. Trees from two hundred and fifty to three hundred feet high and from eight to twelve or even fifteen feet in diameter, immediately above the swelled base, are not uncommon, while old and exceptionally large ones have been found from three hundred and twenty-five to three hundred and fifty feet high and twenty feet in diameter. Old trees are clear of limbs for eighty to one hundred feet in dense forests. It has the habit, possessed by no other valuable species of conifer, of sending up sprouts from its roots that will grow into valuable timber for the saw. When growing in the open, trees up to fifteen inches in diameter show a narrow, regular, conical crown from the ground up, the lower limbs drooping, the middle ones nearly horizontal, and the upper ones slanting upward. Being light-demanding, the lower limbs, if in a dense or approximately dense stand, die and drop off. In old age the whole crown is changed, and a few straggling branches extend far out and the crown becomes irregular, open, and sometimes rounded.

Its natural range is a belt along the Pacific Coast from southwestern Oregon to Santa Cruz, in California. The greatest width of the belt does not exceed thirty, and at some points not over ten miles. Its greatest development is in Mendocino, Del Norte, and Humboldt counties, California, where it may be found along the valleys and against the mountain-sides, but nowhere more than 2800 feet above the

ocean. There is a very fine grove near Santa Cruz that is not over six miles from the ocean or more than two hundred feet above it. It is found nowhere outside of California except on a small area in southwestern Oregon, and all attempts to grow it elsewhere in the United States have proved unsuccessful, although it appears to thrive in Europe. It revels in a moist atmosphere and evidently cannot do without it.

It is being largely cut for lumber in the counties named, and if the present rate and method of cutting are kept up, it will be practically exhausted in thirty years. The method of harvesting is, to say the least, unique. The trees are felled, the bark peeled off, the limbs lopped, and the tree lies untouched until the bark and limbs are dry enough to burn, when fire is set and the whole tract burned over. This is done to get limbs and bark out of the way, the latter sometimes being twelve to fifteen inches thick. The tree is then cut into logs, and such as are too large for the sawmill are split open with powder or dynamite—sometimes even quartered. Seldom is a tree cut for lumber under twenty to twenty-four inches in diameter. Those under that are left to be killed by fire, to be blown down, or to die from changed surroundings. It yields from forty thousand to seventy-five thousand board feet to the acre, and not infrequently three hundred thousand feet. A single case is reported where one million feet were secured from one acre, but the percentage of loss is very great, the same as with the Big Trees.

The wood is about as heavy as White Pine, very soft, brittle, of a purplish, red-brown color, and very durable. It is rather dull when varnished, but makes excellent interior finish, and is used for general construction, siding, shingles, and foundations for buildings, where it is commonly placed without anything intervening between it and the ground. It is claimed that fence posts have lasted thirty-five years without showing decay. It takes paint and glue well. There is little difference between spring and

summer wood, and the medullary rays are small and inconspicuous. It is very straight-grained and splits easily. Railroad ties and fence palings are split out and require little dressing, and shingles six inches wide and three feet long, called "shakes," are split and used without further labor being bestowed upon them. It shrinks endwise appreciably when seasoning. Woodworkers assert that the wood dulls planes and other tools used in working it. It is not valuable for fuel, although used for that to some extent, but mainly because no better can be secured in the vicinity.

The tree is a prolific seeder, but the percentage of fertility is low, not exceeding twenty-five per cent. The cones are small and mature in one season. If permitted, natural reproduction from seed would take place, but as it sprouts freely from the living tree as well as from cut stumps, reproduction would surely result if not seriously interfered with, and, therefore, seed-planting would be wholly unnecessary if fire were kept out, unless additional areas were sought. No one of our valuable timber trees is more susceptible to natural reproduction than this, and yet nothing is being done to encourage or even permit it.

THE OAKS: WHITE OAK CLASS

OF the two hundred and fifty species of Oaks in the world nearly fifty can be credited to the United States, and of these not more than fifteen, if as many, can be classed as valuable timber trees. The lumber trade makes three general classes, Red, White, and Live Oak, and of these the White Oak class is by far the most important. While there is a difference in the character of the lumber produced from the several species of the White Oak class, the consumer, unless an expert, will seldom detect the difference, nor will he be much the loser if he does not. Except for special purposes, such as tight cooperage and the like, the lumber of nearly all species of White Oak now manufactured is equally serviceable. And so, too, it is with the Red Oak class — one tree being about as good as another. But there is a wide difference between the two classes. There are certain features in the wood of the White Oak class that the Red Oak class does not possess, and the distinction between the two should always be understood and insisted upon by both buyer and seller. The division is one based not only on the structural and economic differences in the wood, but on botanical disagreement. In the White Oak class the wood is stronger, more durable, especially when exposed to the weather or in contact with the ground, and is adapted to more economic purposes. One of the botanical differences is with few exceptions that the seeds of the White Oak class mature in one year while those of the Red Oak class require two years.¹

¹ There are two Oaks on the Pacific Slope clearly belonging to the White Oak class that require two years for their acorns to mature, and two as clearly of the Red Oak class that mature theirs in one year. In all other respects they agree with their respective classes. They are of no importance as timber trees.

The possible botanical range of Live Oak is limited to a narrow strip along the coast of the Southern States and in California, the latter, however, producing a very inferior grade of lumber. The large use of steel in shipbuilding has greatly lessened the demand for Live Oak, and its reproduction by planting would hardly be a paying investment. By reasonable care natural reproduction will be quite likely to provide a sufficient supply. Its habit of branching out low down renders it unsuited for saw timber except in short lengths. Its crotches and crooked limbs are used as knees and other like forms in boat- and ship-building.

White Oak Class. All the lumber produced from trees named in this paragraph is commercially classed and sold as White Oak: White Oak (*Quercus alba*), Post Oak (*Q. minor*), Burr Oak (*Q. macrocarpa*), Overcup Oak (*Q. lyrata*), Swamp White Oak (*Q. platanooides*), Cow Oak (*Q. michauxii*), Yellow Oak (*Q. acuminata*) and Chestnut Oak (*Q. prinus*), with several others of less note.

Red Oak Class. Lumber cut from the following list of trees is classed and sold as Red Oak: Red Oak (*Quercus rubra*), Pin Oak (*Q. palustris*), Black Oak (*Q. velutina*), Spanish Oak (*Q. pagodaefolia*), Southern Red Oak (*Q. texana*), with half a score or more of no very great importance, and not worthy of cultivation when more valuable ones can be grown in their stead.

WHITE OAK: *Quercus alba*

OF all the broadleaf trees of America, White Oak is the most important. For some purposes there is no substitute thus far known, and its rapid destruction attests the estimation in which it is held. When standing in favorable locations, trees have been found over one hundred feet high, clean of limb for sixty or seventy-five feet, with slightly tapering body, and over five feet in diameter breast high. The area of its natural range is great. Its boundary stretches from Maine to northern Florida, from there to eastern Texas,

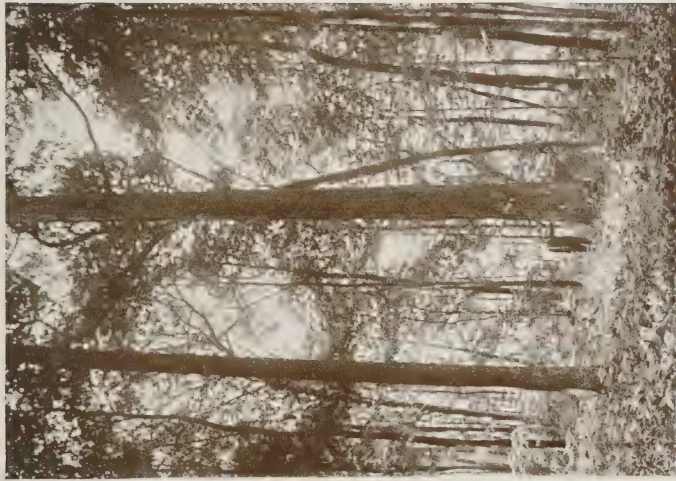
from Texas north to central Wisconsin, and from there across Michigan to the Canadian line and along that line to central Maine and thence to the Atlantic Ocean. The western slope of the Alleghany Mountains and the valley of the Ohio River are the regions of its best development, yet vast quantities of this noble tree have been found elsewhere. In many sections of our country there once stood pure forests of it, and in others it constituted more than one half the stand.

As with other trees, a rich suitable soil is conducive to a vigorous growth, and the rapidity of that growth and the size of the tree depend upon favorable conditions and surroundings. Vigorous and rapidly growing Oaks produce the best lumber. On dry, rocky ridges the tree grows slowly and will not there attain a large size of body, but appears to reach a limit beyond which it cannot go, and the wood is not of the best quality. It is decidedly a light-demanding tree. In the open, it will grow a large, short, and rapidly tapering stem, with wide-spreading, large and frequently specialized limbs, and assumes a rounded, low crown; but when crowded in a forest, it will shoot up a straight stem, free from large limbs until well up, when it will throw out spreading ones and form a somewhat irregular crown, but in the main a round one. As a rule the stem tapers but little when crowded until the large limbs are reached. In some localities small bunches of twigs will be found along the stem, even in quite a dense shade, but these never grow large and do little injury to the lumber.

The wood is strong, hard, heavy, tough, rather coarse-grained, does not split easily, and shows a distinct marking between spring and summer growth. It is durable when exposed to the weather or in contact with the ground. The large amount of acid in the wood serves to protect it from the attacks of many of the fungi. The heartwood is of a rather yellowish light-brown color, with slightly lighter and not very thick sapwood. Its medullary rays are large and conspicuous, and when lumber is sawed radially — “quar-

ter-sawed" is the commercial and trade term — it is one of the most esteemed among our native woods for cabinet-work, interior finish, and floors, only Black Walnut and Black Cherry contesting with it for supremacy. Large quantities of it are cut into veneers for interior finish and the like. It takes high polish, and, when not covered with artificial stain, grows richer in color and transparency of texture as age creeps on. The annual layers are very distinct and show several rows of pores or ducts which must be closed with some kind of "wood filler" before varnish is applied. It seasons well, but when sawed from young and rapidly growing trees is liable to spring and warp and also check if not properly piled and cared for. When sawed tangentially — "bastard fashion," "plain," or "flat-sawed," — its medullary rays are starting-points for checks, and decay enters there when exposed. No wood has a wider range of usefulness. It is used in shipbuilding and for trestles, bridges, piles, railroad ties, carriagework, agricultural implements, and tight and loose cooperage, as well as for interior finish and furniture. For vessels containing wine and other spirits no satisfactory substitute has been found. For purposes where strength and durability are desired it is universally sought.

White Oak is at best a slow grower, but when fairly established it continues in a very regular and uniform way to a good old age, three hundred years or more. As indicated, it cannot stand much crowding, and it is doubtful if more than one hundred trees to the acre, if so many, should be left to mature if the best results for sawed lumber are sought, but the trees must be crowded in early life and until they attain a proper height. There is little probability, however, that future generations will see much White Oak allowed to grow to a profitable size for that purpose. It will be cut for railroad ties and like uses as soon as large enough, which will be when the trees are from sixty to eighty years of age. To let them stand long enough for good width of boards would require more than twice that



WHITE OAK, FOUR FEET IN DIAMETER, NEARLY
FIFTY FEET TO FIRST LIMB. ON FOX ESTATE,
CLARION COUNTY, PENNSYLVANIA

Courtesy of Pennsylvania Department of Forestry.



BIG BURR OAK, CIRCUMFERENCE ABOVE
SWELL, TWENTY-TWO FEET. GIBSON
COUNTY, INDIANA

Courtesy of U. S. Forest Service.

period, and the harvest would probably not be worth enough more to make up for care and interest on the investment.

The natural reproduction of White Oak must come either through seed-scattering by animals — mice, squirrels, and birds — or by sprouting from the stump of a cut tree or the roots of a decaying one. The acorns are too heavy to be blown by the wind and they naturally spread no farther than the limbs of the tree extend, and if they germinate there they will not thrive for want of light; and thus we are left mainly to the animals named for the scattering of the seeds of this tree, as we are for all the heavy-seeded or nut-bearing trees.

Sprout reproduction cannot be depended upon to any great extent, although cut stumps and decaying trees will throw up some shoots, but the habit is not general. Its tendency to do this is much overestimated, through a misunderstanding of the causes which frequently result in two or more trees springing from one and the same root system, which are mistaken for sprouts. Such are not necessarily sprouts, as the term is generally understood, nor do they produce an increase of useful timber. The seedling White Oak has a slow and frail growth for the first three or four years, while the tap-root is running deep into the ground. If an injury occurs to the terminal bud of the tender stem, the lower buds will be forced into growth by the strong and vigorous root system which has been developed, and two or more stems will spring from the same root, each struggling to be leader. Sometimes — and quite frequently — a one- or two-year-old seedling will develop two terminal buds at the end of the season, and the next year both will grow. Frequently one of these will outgrow the other. Such growth is not "sprouting," nor is it reproduction, for all are of the same age, and from the same roots. Genuine sprout growth is weak at best, and timber suitable for anything larger than railroad ties, fence posts, or cordwood should not be expected from it, and one crop of sprout timber will so weaken the root system that it will either die outright or

the second cutting will be of little value. Thus it will be seen that rapid natural reproduction is unlikely to occur under the most favorable circumstances. Moreover, the tree does not bear fruit in early life in the forest — seldom under fifty years.

Having a tap-root well developed when young, and suffering severely from its loss, it is manifest that growing the trees in a nursery and transplanting them into the forest would be quite likely to result in frequent failure. It is not denied that the little tree will recover, to a certain extent, from loss of the tap-root, which will inevitably occur when removed from the nursery, but it is well known that it takes a long time to do it, and it is doubtful if it ever does fully overcome it.

The remaining method of growing a White Oak forest is to plant the acorns where the trees are to stand during life, and this is evidently the best way. It has some drawbacks. The principal one is that the young trees are liable to be overcome and smothered by grass, weeds, or bushes growing on the ground where planted, and it might be necessary, in some cases, to remove such from around the little trees for the first few years. Then there is danger that mice or squirrels may dig up the seeds after they are planted, for the acorns are freely eaten by them. To avoid this, planting would be best done in the spring, the acorns being properly cared for over winter.

The acorns should be gathered as soon as ripe and either planted at once or put in layers with moist sand and kept in a cool place until planted. If not kept cold — freezing will do no harm — the acorns are liable to sprout. It is not an uncommon thing to find them sprouted in the fall where they have been covered with leaves and kept moist, yet they should not be allowed to become dry. In planting, a hole can be made with a sharp stick, or one dug with a mattock, — the latter by far the better way, — and two or three acorns dropped in and covered about one and one half inches deep. If the ground is naturally dry and loose, two

inches will not be too deep, but if moist and compact, an inch may do. The number of acorns named is to insure a tree in each place, as all of them may not prove fertile, nor will all survive. It would be best to scatter the acorns when dropping them, and the superfluous trees can be removed when the best one has become firmly established.

The distance apart that the seeds should be planted must be determined from the character of the ground and the location, and whether other trees are to be planted with them. If alone, they may be put from five to six feet apart each way, and when the time for thinning arrives some may, and doubtless will, be large enough for fence posts ; but if planted ten feet apart, some other species of trees could be set between them to force the Oaks to seek light and drop their lower branches and the nurse trees be removed later. When the Oaks have attained a suitable height, thinning should take place gradually, leaving at last only as many as can be grown in a thrifty condition, which will probably never exceed one hundred and twenty-five to the acre — more likely a smaller number. As Chestnut and White Oak are largely associated in natural forests, the former would be a good “nurse tree” to plant with the latter, but the Chestnuts should not be planted until the second or even third or fourth year after the acorns, for the reason that the Chestnut grows much faster than the Oak. When the Chestnuts are cut, they will throw up sprouts and thus preserve the forest floor in good condition. The great value of White Oak lumber will certainly justify attempts to grow extensive forests of that tree, notwithstanding its slow growth. Unless this is done, it will soon be practically exterminated and the loss greatly felt. The great importance of the tree is the justification offered for this lengthy consideration of its characteristics, growth, and cultivation.

SWAMP WHITE OAK: *Quercus platanooides*

THE common name of this tree indicates its habitat as correctly as it does the class to which it belongs. In general appearance, however, it quite resembles the Chestnut Oak, and could appropriately be called Swamp Chestnut Oak. Both its leaves and bark more closely resemble Chestnut Oak than they do White Oak, yet its wood is very similar in appearance and quality to that of the latter tree, and it is sold as such with little or no wrong to the purchaser. Its natural range is from the New England States westward to Iowa and Missouri, southward along the Appalachian Mountains to northern Georgia, and in the East from Maine to Virginia. It is nowhere very abundant, though it can occasionally be found in small groves. Its best development is in western New York, northwestern Pennsylvania, and northern Ohio. It may be seen along streams in low, rich ground, around and along the borders of and even in swamps, mingled with other trees that flourish in moist or wet ground. It is only moderately light-demanding.

The tree has been known to reach a height of one hundred feet with a diameter of seven or eight feet; but such growth is extremely rare. It seldom exceeds seventy-five feet in height or three feet in diameter. Standing where it is constantly supplied with moisture, its growth, after the first five or six years, is quite even and rapid. Notwithstanding that it does not object to wet feet, but rather prefers that condition, it will grow well in any moist, rich soil.

The wood is hard and heavy, tough, strong, close-grained, and very durable when in contact with the ground. The heartwood is light brown, with thin and barely distinguishable sapwood. Its medullary rays are as prominent and as conspicuous as in White Oak, which makes it acceptable for furniture and interior finish. It is used for all the pur-

poses that White Oak is, — and the tree may be accepted as a White Oak adapted to growing in wet ground.

Its propagation should be undertaken along the same lines as White Oak, although it does not develop a prominent tap-root except when growing on dry ground. It matures its seed in one year. Unfortunately it does not shed its lower limbs readily even when crowded, but these are seldom large enough to injure the lumber seriously. Close planting may modify that characteristic; anyway, close planting would have that tendency. No information can be obtained that its propagation has ever been attempted. There would certainly be no reason to undertake its cultivation where White Oak will grow, but it may be undertaken where White Oak will not thrive.

There is another Swamp White Oak, *Quercus lyrata*, commonly called "Overcup Oak," ranging from northern Maryland southward to northern Florida and westward to northeastern Missouri. Its name, "Overcup," was bestowed upon it because the cup nearly or quite covers the acorn. Its general characteristics are practically the same as that of the Swamp White Oak just described, and hence a detailed account of this one would be superfluous. Aside from some little difficulty in seasoning, its wood is as valuable as that of the other.

CHESTNUT OAK : ROCK OAK : *Quercus prinus*

IN their general outline the leaves of this Oak resemble those of the well-known Chestnut (*Castanea dentata*), and hence the name "Chestnut Oak." In some sections it is known as "Tan Oak," because its bark is rich in tannin, the most so of any of the Oaks; and, as it frequently grows in rocky situations, it is sometimes called "Rock Oak." It is very common in the Appalachian Mountains from Pennsylvania to northern Georgia and Alabama. Its best development is on the lower mountains of eastern Tennessee and Kentucky and in the western part of the Carolinas, where

it is frequently the prevailing tree. While growing in the New England States, it does not appear to be very evenly distributed or very abundant there. It flourishes best in deep, rich soil, but will grow on dry, sterile, and even rocky slopes and hillsides. In its best development it has been found one hundred feet high and six feet in diameter, but trees of these dimensions can be seen only in rich soils, and rarely there. In poor soils it is much smaller, seldom over three feet in diameter or more than fifty feet in height; while in some localities it does not exceed ten inches in diameter, with a height of not over thirty or forty feet, even at the age of one hundred years.

It is light-demanding, and unless closely crowded during early life it branches out anywhere from six to fifteen feet above the ground with somewhat specialized limbs. When not crowded, it frequently grows crooked. When young its bark is quite smooth, but as age increases, the bark becomes deeply furrowed vertically, more so than on any other Oak. The dead bark does not scale off, and it will frequently be found nearly if not quite three inches thick. At best the tree is a rather slow grower.

Its wood is tough, heavy, hard, strong, durable, rather close-grained, and with conspicuous medullary rays. It has few open ducts and requires less "filler" for a good finish than most Oaks. When finished without stain, its hard, satiny, and lustrous surface is deemed superior to White Oak. The color of the heartwood is rather darker than the average of White Oak, with a light-colored sapwood. One serious drawback to its usefulness as a finishing-wood is its tendency to check when seasoning. This can be largely overcome by proper piling. In substantially all respects the wood is used for the same purposes as White Oak, and for fuel is superior to any other Oak.

It is not a prolific seeder, and as the acorns are sought by squirrels and mice, its natural reproduction is slow. It has a tap-root which will prevent successful transplanting from the nursery; hence its reproduction can best be brought

about by planting, as recommended for White Oak. Belonging to the White Oak class, its acorns mature in one year. The distance apart that the seeds should be planted in the forest must be largely determined by the character of the soil and the location. If in fertile, moist ground five to six feet would be advisable, but if on dry, rocky, and sterile ground, then four to five feet would be far enough apart.

BURR OAK: *Quercus macrocarpa*

THIS tree is most generally known as Burr Oak, although in some sections of the country it is called "Mossycup Oak," from the fact that its acorn is largely covered by a cup which is clothed with pointed scales, having a loose fringed border ; and this name is not at all inappropriate. It is an important member of the White Oak class and in many respects is a close competitor in general usefulness with the White Oak. Its botanical range is greater, and while it prefers low, rich bottom lands along rivers and smaller streams, it will accept high grounds if fertile ; but it does not grow on uplands as readily or thrive as well there as White Oak. Its range covers, intermittently, the entire country east of the foothills of the Rocky Mountains, excepting the Carolinas, Georgia, Florida, Alabama, Mississippi, and parts of Texas and Tennessee. It attains its greatest size in Indiana and Illinois, where it has been found one hundred and sixty feet high and six feet in diameter, with a stem clean of limbs for a height of seventy-five feet or more. It has broad-spreading branches and is a giant among its associates. It will make up a pure forest or thrive with such companions as seek the soil it prefers. It largely formed the well-known "oak openings" in some of the Western States. Like nearly all other Oaks, it is intolerant of shade. It has a thick deeply furrowed bark, and in this it is equaled only by the Chestnut Oak.

Its wood is strong, hard, heavy, tough, close-grained,

and durable. The heartwood is a rich yellowish brown, sometimes quite dark, with a thin, light-colored sapwood. Its annual rings are conspicuous and spring and summer wood are quite distinct. It has broad, conspicuous medullary rays, which add to its good qualities when used for furniture or interior finish. It is used for substantially all purposes to which White Oak is adapted.

It is a slow grower unless in rich moist soil, in which case it frequently outstrips White Oak. There is apparently nothing about it to prevent its cultivation in soil adapted to it. It has been planted to a limited extent in the West, and where conditions are favorable it flourishes. Its cultivation should evidently be along the same lines that must be pursued for White Oak. Like that tree it has a tap-root, but does not appear to object so seriously to interference with it. Gathering and caring for its seed must be the same as for other Oaks. The acorns mature in one year. Probably the best distance apart to plant the acorns or trees in the forest would be from five to six feet, according to fertility of soil.

COW OAK : *Quercus michauxii*

LIKE the Swamp White Oak, this tree grows along streams and on the borders of swamps, and can endure standing in water for some time without apparent injury. Like that tree, also, its leaves resemble somewhat those of the Chestnut Oak. Its bark, however, is more nearly like that of the White Oak than any other. It is quite probably a hybrid. There is some question whether this and the Swamp White Oak are not varieties of the White Oak changed by conditions of soil, climate, or surroundings.

Its natural range is south of that occupied by the Swamp White Oak, closely following the southern line of that tree's range. It reaches to northern Florida and the Gulf. Westward it goes to eastern Texas, Indian Territory, and southern Missouri. In the forest it grows to a height of one hun-

dred feet with a diameter of five or even six feet, with a clean stem for fifty or more feet. Like nearly all other Oaks, it is intolerant of shade.

The wood is hard, heavy, tough, strong, coarse-grained, and durable. The heartwood is a light brown, with a thin and darker-colored sapwood. Its medullary rays are large and conspicuous, but not numerous, and its annual rings are clearly shown. There is a distinct difference between the spring and summer wood, the pores in the former being very prominent. Its wood is quite like that of the White Oak, differing mainly in being more easily split, especially between the annual layers. This feature makes it available for basketwork and has given it the name of "Basket Oak" in some localities. It is used for interior finish, cabinet-work, general construction, railroad ties, and substantially all purposes for which White Oak can be used. The tree could very appropriately be called the White Oak of the Southern States, and, excepting the Southern Red Oak, it is, no doubt, the most valuable broadleaf tree growing there.

Unfortunately it does not appear to flourish on dry ground, and until it is experimentally shown that it will grow there, its cultivation should be confined to its natural soil. As it naturally grows where nearly all other valuable timber trees refuse to grow, this, aside from its good qualities as a timber tree, is an additional reason for its cultivation. Standing more or less in the water, it has no need of a tap-root, and hence that feature has not been greatly developed, as in most other Oaks, and there should be little difficulty in transplanting it when young, and the moist ground in which it grows should insure success. But this would be experimental, for there are no known efforts in that line. Its propagation by planting seeds would certainly be a safe undertaking, for that would be but following Nature. Gathering and planting the acorns — they mature in one year — should be the same as for other Oaks, and the distance apart for planting, the same. As the ground should be at least moist where the seeds are planted, it would naturally

follow that they should not be covered as deep as would be necessary on dry ground.

POST OAK: *Quercus minor*

THIS Oak is classed and sold in the lumber market as White Oak, and it has some of the good qualities of that noted tree, but by no means all. Its natural range is a wide one and is included in a boundary line running from Cape Cod along the Atlantic Coast to northern Florida, from there along the Gulf to Galveston, thence northward to Kansas, and from there in almost a direct line across Missouri, Illinois, Indiana, Ohio, and Pennsylvania to Massachusetts. In localities of its best development trees have been found one hundred feet high and three feet in diameter, but this is far above the average. It varies greatly in character with location. It is somewhat dwarfed in some sections, and in its extreme northern range may frequently be found small and of little value, except for fence posts, from which fact its common name no doubt arose. It prefers a dry, sandy soil. Unfortunately it does not appear to be willing to drop its lower limbs and grow tall and smooth far up from the ground, no matter how much it may be crowded by neighbors. What systematic forestry might bring about is uncertain. The shape of the leaf of the Post Oak is peculiar. From the stem to about one half its length it closely resembles that of the White Oak. It then broadens and from there on to the point its shape is substantially the same as that of the Chestnut Oak.

The wood is heavy, hard, strong, close-grained, and durable in contact with the soil. Its annual rings are well marked, and there is a broad distinction between spring and summer wood. Its medullary rays are numerous and quite conspicuous, causing it, together with the color of the wood, to resemble White Oak closely. The heartwood varies in color from light to dark brown, with a thick and lighter-colored sapwood. It is difficult to season, checking badly

when drying. Were it not for this feature it would prove a good substitute for White Oak for furniture, interior finish, and tight cooperage. It is mainly used for railroad ties, general construction, fencing, and fuel—sometimes for heavy carriage and wagon work.

It is altogether probable that its artificial propagation, except by seed planting, will not be successful if attempted, its tap-root making removal from the nursery a very difficult task at best. At all events, it should be undertaken with caution. Reproduction can surely be brought about by gathering and planting the acorns as recommended for White Oak. However, as White Oak can be grown in much of the territory where Post Oak flourishes, the former should be planted there in preference. Still, as Post Oak will grow in poorer soil than White Oak, care should be taken to grow it there, and a proper selection of the ground made.

CHINQUAPIN OAK: YELLOW OAK: *Quercus acuminata*

THIS is another of the White Oak class with leaves largely resembling those of the Chestnut, and varying but little from the leaves of the Chestnut Oak (*Q. prinus*). They gradually taper to an apex, hence the botanical designation *acuminata*. Its natural range is substantially the same as that of the Chestnut Oak, except that it extends farther west, invading Kansas. It is by no means of uniform growth, and in some localities is somewhat dwarfed. Its best development appears to be on limestone soils in the Mississippi Valley, where it flourishes on ridges and hills as well as on rich bottom lands and rocky banks of streams. It is not frequently found in the Atlantic States, but is quite common west of the Alleghany Mountains, extending from there to Kansas. When growing in its favorite soil the tree sometimes reaches a height of one hundred and twenty feet with a diameter of four feet. It is light-demanding, and therefore will grow tall and free from limbs to a great height if crowded when young.

The wood is very heavy, hard, strong, and durable, fairly close-grained, but not tough. There is a distinct difference between spring and summer wood and the annual rings are easily distinguished. The medullary rays are thin and by no means prominent. The color of the heartwood is a light yellow brown, with sapwood still lighter in color. It is used for substantially the same purposes as White Oak, although not as acceptable for cabinetwork and interior finish, nor for tight cooperage, as it checks badly when drying.

If propagation is attempted it should be along the lines laid down for White Oak, as it has a tap-root. It ripens its seed in one year. It is not a rapid grower, and in many localities not equal to the White Oak, and if the latter will flourish where this one will, it would best be planted in its stead. The tree should not be confounded with Black Oak, which is sometimes called Yellow Oak. That is of the Red Oak class. Its name "Chinquapin" is a misnomer, for the Chinquapin belongs to the Chestnut family.

RED OAK CLASS

OF the Red Oak class there are but few of the twenty-four different species in the United States which may be considered of sufficient importance to warrant undertaking their cultivation. These few, however, may well demand attention. They are Red Oak (*Quercus rubra*), Swamp Spanish Oak (*Quercus pagodaefolia*), Black Oak (*Quercus velutina*), and Pin Oak (*Quercus palustris*). There are some others which might be profitably propagated in restricted locations where better species will not grow and prove of value, but their ranges are limited.

The Red Oaks, with two insignificant exceptions, require two years to perfect their fruit. The bark and leaves are so unlike those of the White Oak class that there is no difficulty in determining their character or where they belong. It is not always easy, however, to decide, by the shape of the leaf, which one of the Red Oak class a tree may be, for it is not infrequent that two, and sometimes three, leaves quite differently formed may be found on the same tree. The wood of the Red Oak very much resembles that of the White Oak, but it does not require the knowledge of an expert to determine to which class it belongs.

RED OAK : *Quercus rubra*

NOT until within the last fifteen or twenty years was this tree considered of much value, because of the superiority and cheapness of its more important relative the White Oak. As the supply of that wood waned and the price rose, attention was turned to the large, vigorous trees of Red Oak from which wide lumber could be cut. It was at last discovered that the tree has many good qualities. It is a rapid grower — the most so of all the Oaks — and it lives

long and grows to a great size. It is hardy, will grow tall, straight, and free from limbs if crowded in early life. It can be transplanted when young with fair success, and, in addition to its value for lumber, there is considerable tannic acid in its bark. So many good qualities does it possess that it is largely planted in Europe and is deemed equal to any of the Oaks there grown.

Its range is from Maine to Minnesota and southward to Kansas, Alabama, and North Carolina, and along the Atlantic Coast northward. In the region of its best development—which is in the central and southern portions of the Northern States—it has been frequently found one hundred and twenty-five feet high, and even more, with a stem six feet in diameter. It is the smallest in the extreme northern limits. It thrives well in glacial drift, in the carboniferous formations, and in alluvial deposits, but prefers an easy slope of hillside and a well-drained soil. The rapidity of its growth is much affected by the character of its surroundings and soil. Frequently lumber cut from it will show a slow growth and in other cases a very rapid one. Dr. J. T. Rothrock, in his report as Commissioner of Forestry of Pennsylvania, for 1895, relates that he counted the annual rings in a Red Oak tree which was just four feet in diameter and found only one hundred and eighty. That averaged twenty-six hundredths of an inch per annum, or substantially one eighth of an inch of annual layer. It thrives well in practically pure stands or mixed with other broadleaf trees and with Hemlock, but it is generally found with other Oaks and Chestnut. It is eminently a light-demanding tree. When grown in the open, it will branch out low down and throw out limbs which grow large and spread out nearly horizontally; but if crowded in early life the tree will push upward until it gets light or die in the attempt. In dense growth the stem is slightly tapering and generally straight.

The wood is heavy, hard, strong in rapidly growing trees, but generally brittle in old or slow-growing ones,



RED OAK, FOUR FEET IN DIAMETER AND MORE THAN FORTY FEET TO FIRST LIMB. CHESTNUT AT
RIGHT WHICH HAS BEEN STRUCK BY LIGHTNING. JEFFERSON COUNTY, PENNSYLVANIA

coarse-grained, seldom tough, and has well-marked annual rings, showing plain distinction between spring and summer growth. The heartwood is light brown or red with rather thin, darker-colored sapwood. The medullary rays are neither so broad nor so conspicuous as in White Oak. There is considerable tannic acid in the wood. The wood is not durable when exposed to the weather or in contact with the ground. It is easy to work, takes a good finish when the pores or ducts are filled, but is quite given to checking when seasoning; but this can be largely obviated by proper piling. It takes glue well, but, as with all other woods, heartwood should be joined to heartwood and sapwood to sapwood. It is used for interior finish, furniture, some kinds of cheap cooperage, general construction, and even clapboards and shingles. When chemically treated, it makes a very good railroad tie, especially if the tree from which it is cut is healthy and vigorous. Several railroad companies are planting it for that purpose with a view to treating it chemically. It has its defects. One is that cracks will frequently be found in large trees reaching from the centre quite out to the sapwood and running from the ground twenty or thirty feet upward. Unless properly placed on the mill carriage the saw cuts across these checks and spoils more or less lumber. Another defect is that old trees are infested with worms the same as old Chestnut.

Red Oak sprouts from the stump quite freely, and if properly cared for, natural reproduction will take place after a fashion, but, as with other trees that throw up sprouts, the second generation will be so weakened as to be of little value. Sprouts of Red Oak rarely attain a size suitable for the saw and are almost invariably more or less decayed at the butt. This is the experience of practically all lumbermen who have harvested such growth.

The tree is a prolific seeder, bearing large acorns, which are so bitter and so highly charged with tannin that few animals will eat them. They require two years to mature. Propagation by planting the acorns where the trees are to

stand, or sowing them in a nursery and transplanting them into the forest when two or three years old, is entirely feasible. While it develops a rather conspicuous tap-root, it will, like the White Ash and several other trees, suffer its removal in early life without seriously checking its growth, for it naturally takes on lateral roots as it passes out of babyhood. If young trees are grown in the nursery, — and that is what is done to a great extent in Europe, — they should be taken out of the seed-beds at the end of the first year's growth, the tap-root removed, and the little trees set in the transplant nursery, there to remain for one or two years, when they can be removed to the forest without much loss ; or, if conditions are favorable, they can be set out in the forest when only one year old. At that age they average eight inches in height.

Notwithstanding the fact that the tree can be successfully transplanted when young, planting the acorns where the trees are to grow, as with White Oak, is preferable if the ground is not too densely covered with bushes, grass, or weeds. This is less expensive and saves at least two years' time in tree-growth. To guard against failure to germinate, two or more acorns should be planted in each place. If set out or planted as a pure stand, — no other trees mixed with them, — six by six feet apart would be a good distance, and at the final thinning they could be left eighteen feet apart, or a few more than one hundred and thirty to the acre, which would be a close stand for mature Oaks of any kind.

All things considered, the tree is eminently worthy of propagation, and care should be taken to protect all now growing and efforts put forth largely to increase the stand. If the seeds are planted in the fall — in that case there is little danger of animals disturbing them — it should be done early, for the acorns frequently sprout soon after falling from the tree. If stored until spring, they should be stratified in sand and kept in a cool place and planted as early as possible.

BLACK OAK: *Quercus velutina*

THE common names given to most trees appear to arise from some peculiarity of appearance either in bark, leaves, or wood, and the Black Oak is no exception. It was called Black Oak, no doubt, from the dark color of its dead bark, which, however, is not always black but sometimes brown, and on many trees only a dark gray. If examination should be made of its live inner bark, another name could be very properly given it, — and it has been, — and that would be “Yellow Oak.” However, it is known as Black Oak in twenty-five states of our Union, and by that name it should be called, notwithstanding that its inner bark is yellow and the lumber dealer persists in calling it Red Oak to his customer. This tree should not be confounded with another Oak called “Black Jack” (*Quercus marilandica*), which may be found more or less spread over much of the territory in which the former grows. An inspection of the inner bark will at once determine whether the tree is the true Black Oak under consideration. Many times Red Oak is called Black Oak, simply because its outer bark is dark colored, and it is quite difficult to determine between them by general outward appearance or by the character of the wood.

A line running along the coast from southern Maine to Florida, thence along the Gulf to eastern Texas, from there north to Wisconsin and then to Maine, would inclose the region of its natural range. Its best development may be found in southern New England and the central portions of the Middle States. In some localities it is much dwarfed. It is quite exacting as to character of soil and location. It prefers rich, well-drained bottom lands, but will grow well on fertile uplands and hillsides. It does not thrive on dry, sterile soil. It sometimes reaches a height of one hundred and twenty-five feet, with a stem four feet in diameter, but such trees are not common. It is not a rapid grower, but

lives to a good old age. Its branches are slender when close-grown and even then form a somewhat open crown. It will grow tall and slender when crowded, as it is a moderately light-demanding tree, but when grown in the open it has a stocky, rapidly tapering stem, with wide-spreading limbs from the ground up, and forms a round crown. No other Oak produces so many differently shaped leaves on the same tree as this. So far as its leaf form is concerned, it apparently has not decided what one to adopt exclusively.

Its wood is strong, heavy, and hard, but not tough. It is more durable than Red Oak, but not equal to White Oak, and it checks when seasoning. The heartwood is light brown, somewhat tinged with red, with lighter-colored and rather thin sapwood. It is coarse-grained, and its spring and summer wood easily distinguished. The medullary rays are thin and inconspicuous for an Oak. It is used for nearly all purposes for which Red Oak is suitable.

Formerly its inner bark was in considerable demand, as an extract of it was largely used as a yellow dye. It bore the name of "quercitron" and was a distinctive article of commerce, and the tree was consequently called *Quercus tinctorium*. The inner bark is rich in tannin, astringent, and extremely bitter.

It is tap-rooted, and so far as can be ascertained stubbornly so. While no experience in propagating can be pointed out, it is safe to say that it can be accomplished far better by planting the acorns where the trees are to grow than by any other method; and planting young trees from the nursery would not be likely to succeed. It does not sprout freely. It is a fairly good seeder with not very large acorns, which are intensely bitter and astringent, and they require two years to mature. Should cultivation be undertaken, the acorns should be gathered and treated the same as recommended for other Oaks. Since the introduction of aniline dyes, the value of the tree has been greatly lessened, and attempts at its propagation would be warranted only where no better trees can be grown.

SPANISH OAK: *Quercus pagodaefolia*

THIS species of the Red Oak class can be found from southern New Jersey to Florida and through the Gulf States to eastern Texas, Arkansas, southwestern Missouri to middle Tennessee and Kentucky and northern Illinois and Indiana. It is very generally called Spanish Oak, escaping, as many have not, a multitude of strange names. Its best development is along the swamps of the Mississippi River, in the Yazoo basin, and in eastern Arkansas, where it grows to be one hundred feet high and five feet in diameter, quite clean of limbs for forty or fifty feet, and is one of the important timber trees of those localities. It prefers rich bottom lands and alluvial banks of streams, and does not seriously object to the borders of swamps too wet for many other trees. Like all other Oaks it demands light, and must be grown in a crowded situation until it reaches nearly or quite its natural height-growth, when it will form a comparatively small crown; but when grown in the open it will throw out limbs low down and form an open and wide-spreading crown.

The wood is largely used in place of White Oak and is probably among the best of the Red Oak class for some purposes. The heartwood is light red with a tinge of brown and the sapwood is thin and nearly white. The annual layers are very distinct, the summer wood being much more compact than that of spring, with few but conspicuous medullary rays. The greatest obstacle to its general use lies in the difficulty in seasoning it, as it checks badly. Were it not for this defect, it could, no doubt, be made a substitute for White Oak in tight cooperage. It is used to some extent for oil barrels, largely for general construction work, and also for furniture and interior finish, and in each case as a substitute for White Oak.

It cannot be ascertained that any effort has been made looking to its propagation; but it would, no doubt, be suc-

cessful in its natural habitat, as it is a moist-ground tree and may not seriously object to the destruction of such tap-root as it possesses. Yet nothing but experiment can determine that. There can be but little doubt that planting acorns would be successful. These require two years to mature. It generally makes a fairly good growth, but sometimes a rapid one for an Oak.

There is another species of Oak closely resembling *Q. pagodæfolia*, which for a time was considered only a variety brought about by soil conditions. Like the other it is commonly called Spanish Oak, but its botanical name is *Quercus digitata*. Its natural range is nearly the same as that of *Q. pagodæfolia*, but it grows on higher ground, and does not attain the same dimensions, nor is its wood as valuable, although quite like it in general appearance. Both Spanish Oaks are classed in the lumber market as Red Oak and the purchaser will not secure the best one by naming it, for the dealer may not know which he offers. The tree under consideration — *Q. digitata* — seldom attains a height of eighty or a diameter of three feet. The wood is used for coarse construction, fuel, and fencing, but is not as durable as that of the other species, nor is it as tough. The bark is rich in tannin. Undoubtedly propagation would best be undertaken by planting acorns.

PIN OAK: *Quercus palustris*

PIN OAK has several common names, but the one here accepted is more frequently used than any other. It does not rank very high as a timber tree, even among the Red Oak class, to which it belongs ; but for all that, it has some redeeming qualities. It is a rapid grower for an Oak, only the Red Oak excelling it. Being light-demanding, it will, when crowded, grow a straight, undivided stem, with comparatively small limbs, but will persist in retaining many of them, though they may grow but very little in size. It does not attain the large dimensions of the Red, Spanish,

or Black Oak, nor will it drop its lower limbs so completely when crowded. It is reported to have been found with a stem one hundred and twenty feet high and four feet in diameter. It takes on a pyramidal form of crown in the open, with the outer ends of its topmost branches elevated, the middle ones more or less horizontal, and the lower ones drooping, and forms a singularly beautiful ornamental tree, the most so of any of the Oaks.

Its natural range is from southern New England to Wisconsin, south to Virginia, central Kentucky, and northern Arkansas. Its best development is in the valley of the Ohio. It flourishes in the rich, moist soil of river bottoms, along streams, and in the borders of swamps, but takes kindly to any fertile soil, and may be found quite abundant even on the slopes and summits of the Alleghany Mountains.

The wood is heavy, strong, hard, tough in young trees, coarse-grained, and checks badly in seasoning. The heartwood is a light brown, frequently variegated, with nearly white sapwood. Its annual rings are easily detected and its medullary rays are numerous and prominent. It is not generally considered durable when exposed to the soil or weather, but its resistance to decay when used as a railroad tie appears to vary with the location or section of country in which it grows, for there are well-attested cases where it serves a very fair purpose. Whenever it can be secured without knots or season checks, it serves well for interior finish and furniture. Its general use is for cheap construction, cheap cooperage, even shingles and clapboards, but it cannot serve a very satisfactory purpose for either of the latter.

It is little given to sprouting, but is readily grown from seed, and is one of the very few Oaks that will bear transplanting without seriously affecting its subsequent growth; no Oak surpasses it in this respect. It is tap-rooted, but for all that, it is furnished with many fibrous roots and takes on lateral ones in early life. Possessing these features, it can endure having its tap-root removed without much

injury, and when that is done while young it quickly overcomes the shock. This being the case, propagation in the nursery is entirely feasible, although planting the acorns where the trees are to grow can be successfully carried out. If planted in the nursery the seedlings should be removed from the seed-bed when one year old and allowed to remain in the transplant bed for one or two years as conditions may dictate. The acorns require two years to mature. Gathering and caring for them should be the same as for other Oaks. When planted in the forest they should be spaced about five feet apart to kill off the lower limbs.

SOUTHERN RED OAK: *Quercus texana*

FOR economic purposes this is doubtless the most important Oak in the Southern States. In character of wood it ranks equally as high as that of the Northern Red Oak (*Quercus rubra*), to which it is closely allied, and it is frequently found mingled with it in the southern forests. While no definite information relative to the remaining stand can be obtained, it is more than probable that it is greater than that of the Red Oak of the North.

Its natural range extends from southern Illinois and Indiana down the valley of the Mississippi River to the Gulf, spreading out westwardly to the mountains of Texas, and eastwardly to Florida. Its region of best development is along the bottom lands of the Mississippi River, on land lying between the swamps and the adjacent higher ground. In Texas it grows on the low hills as well as along streams. Its forest companions are usually Red Gum, Elm, Cottonwood, Ash, and Hickory. The tree is of magnificent proportions, frequently reaching a height of one hundred and seventy-five feet, with a diameter of over seven feet. Larger dimensions are reported. Like its Northern congener it is light-demanding and a rapid grower, and it is otherwise quite like that tree in general characteristics. Its leaves, however, more closely resemble those of the Scarlet Oak.

The wood closely resembles that of the Northern Red Oak ; is heavy, strong, coarse-grained in rapidly growing trees, hard, not durable in contact with the ground, with light, reddish brown heartwood, and rather thin, lighter-colored sapwood. Its medullary rays are not large. They are short and somewhat conspicuous, but are not considered an important feature, and much of the lumber cut is "plain" sawed. It is largely used for furniture, interior finish, — its coarse grain showing distinctly, — and general structural purposes for which such wood is suitable. It is quite difficult to season without checking.

No information can be obtained of any attempt to cultivate it. Even natural regeneration is not allowed to take place. Like all Oaks it has a tap-root, but whether it is so prominent as seriously to interfere with transplanting cannot be ascertained. It matures its acorns in two years, and no doubt planting these would be successful. Evidently the same treatment as for other Oaks should be given it. As the natural habitat of the tree is on ground suited to cultivation, it is in the line of ultimate extinction unless measures are taken to plant it or to allow natural reforestation to take place.

THE ASHES

THERE are sixteen species of Ashes in the United States, but barely six of them produce merchantable lumber. These are White, Red, Green, Blue, Black, and Oregon Ash. In the lumber trade all but the last two are classed and sold as White Ash. This is not a strictly correct classification, for two of them — Red and Green — produce lumber somewhat inferior to White Ash, while Blue Ash is superior for some purposes. Still, for most uses there is little practical difference in value and it cannot be claimed that there is much wrong done by this classification. Black Ash is classed alone, for its wood is widely different, although it is used for many purposes that the others are.

WHITE ASH: *Fraxinus americana*

THIS species leads all others in value when quality of wood, size of tree, length of life, adaptableness to varying conditions of soil, and facility of propagation are considered; and probably there has been more White Ash lumber consumed in this country than of all the other species of Ashes combined. Its natural range is from Maine to northern Florida, westward, intermittently, to Minnesota, and, in some localities, across the Mississippi River into eastern Kansas and Nebraska, and its botanical range is, no doubt, greater. Its best development is claimed to be in the Ohio River basin. Very fine specimens were found in Pennsylvania, especially on the gentle slopes and along the streams of the Alleghany Mountains. It was there frequently seen from one hundred to one hundred and twenty-five feet high and four feet in diameter with a straight and slightly tapering stem, clean of limbs for fifty to sixty feet or more. It was never found in pure stands, but mixed with other broadleaf

trees, and sometimes where even White Pine and Hemlock were to be seen. It prefers a rich, moist soil, but not excessively moist, yet it will grow in almost any that is neither very dry nor very wet.

It is a light-demanding tree, and when grown in the open, branches out low down and forms a symmetrical round crown, with limbs largely destitute of leaves except at or near their extremities; but when crowded from early life, it shoots upward, dropping all its lower limbs, and forms a tall stem which, when it reaches its vantage-point, breaks out into a round, open crown, with a few specialized branches. The stem sometimes shows slight bends from one side to the other, but soon coming back to the perpendicular, unless interfered with in some way. An examination of the terminal bud will show how this may happen. There are three winter buds formed on the leader, and if injury comes to the central one, then one or the other, and sometimes both, of the side buds will start forth to become the leader. In case both become leaders, then there will be a forked tree, but if only one attains that preëminence, then a bend will occur, and the new leader will assume an upright direction. It is seldom that any serious injury comes to the lumber cut from such a tree in consequence of this peculiarity.

It is a rapid grower for the first fifty to seventy-five or even eighty years of its life, varying, of course, from supply or lack of fertility, moisture, and depth of soil. During the first half of the last century several White Ash trees were set out on the Pennsylvania State Capitol grounds at Harrisburg, and when two of them were recently cut down to make room for the new building, they disclosed sixty-five annual rings in the stumps two feet above the ground, and were, respectively, twenty-two and twenty-two and one half inches in diameter inside the bark. The wood in these trees was remarkably strong and elastic. When not generously given light, it grows less rapidly and the lumber is inferior in strength and elasticity.

The rapidly grown wood is of great value for many purposes. For some uses it is superior to White Oak. It has long been celebrated for its toughness and elasticity. Homer armed his heroes of the Trojan War with ashen javelins and gave his sailors ashen oars. The average lumber cut from forest trees is hard, heavy, elastic, tough, strong, fairly close-grained, but showing distinct annual rings, with moderately plain distinction in density between spring and summer wood. The color of the heartwood varies in different trees from a light to a reddish brown, sometimes strangely marked with splashes of darker and varying color which run fantastically across the annual rings. The sapwood is thick and light-colored. The medullary rays are small and inconspicuous. It is highly prized for agricultural implements, carriagework, automobile bodies, handles, — the coal miner prefers an ash handle for his pick to all other wood, — oars, and all purposes where strength and elasticity are required. It ranks next after Beech and Maple for fuel. It is not durable in contact with the soil, and the claim that it serves a good purpose for fence posts is not founded on experience. Lumber cut from it does not warp or check badly when properly piled, but logs cut from it should be painted at the ends or promptly sawed into lumber to avoid checks. It is quite long-lived, sometimes reaching an age of two hundred and seventy-five years, but the wood in very old trees is liable to be brittle.

While it will sprout from the stump when quite young, that method of propagation cannot be depended upon. Old trees never sprout. When grown in the open, it has been known to produce seed sparingly at thirty years of age. It cannot be relied on to produce seed oftener than once in three years, and sometimes will not seed more than once in five or six years, and, again, it has been known to bear seed annually for several years; but in such cases the trees stood in the open and were old and showed symptoms of decay. As the White Ash is what botanists call *dicæious*, that is, the staminate flowers are borne on one tree and the

pistillate on another, there may be difficulty in securing fertile seeds. Unless the male and female trees stand close enough for the fertilizing pollen to be borne from the former to the latter, by winds or insects, there is no possibility of fertile seeds being produced,—unless both kinds of flowers are borne on the same tree, which is a disputed point. There is no doubt but that this peculiarity accounts for so few seeds germinating, as nurserymen well know that not more than forty per cent can be depended upon to grow.

The tree blossoms before the leaves are fully developed, and the seeds are ripe by the first of October. They should be promptly gathered and either sown at once, or cared for where they will not get very dry or become wet and mouldy. If allowed to dry, many seeds, though fertile, will not germinate until the second year after being sown. The seeds should be sown in the nursery in rows twelve inches apart, an inch apart in the row, and covered from three eighths to one half inch deep, with soil gently packed or rolled. The bed should be kept as uniformly moist as possible until the plants are an inch or so high. By that time the roots will have penetrated the soil more than twice that distance and they can then endure dry weather fairly well. If conditions are favorable, the seedlings may be expected to reach a height of from six to fifteen inches or more the first year, while the roots will have gone down two or more feet. This fact makes it necessary to remove the seedlings from the seed-beds when one year old, to secure the best results. They may be transplanted directly into the forest, but would best be placed in the transplant nursery for a year. As the tree throws out lateral roots early in life, no great injury comes from cutting off the tap-root some six inches below where the surface of the ground was when it stood in the seed-bed, providing the fibrous roots are abundant on the part to be left ; if not, the root should be left somewhat longer. Care should be taken in removal from the seed-bed not to destroy the fibrous roots, which

may, and should, be left on, as the roots are easily broken at this age.

Close planting in the forest is absolutely necessary to force the tree to grow tall and free from limbs. The United States Forest Service¹ recommends four feet each way as a suitable distance. This would necessitate early thinning, but if carefully looked after, that distance would, no doubt, be about right. At all events, it should not be much more.

Much space has been given to this tree because of its intrinsic value as a timber tree. Next to the White Oak it is the most valuable of all the genuine hardwoods, and its propagation is not difficult, nor is there any reason why it should not be undertaken where conditions are favorable.

RED ASH: *Fraxinus pennsylvanica*

IN many respects Red Ash resembles the more important White Ash. The economic difference is that it does not grow as large, its wood is not quite as valuable, and it prefers a moister soil. The non-botanist can determine whether a tree is a White or a Red Ash by examining its twigs and leaves. If there should be found on the twigs, or underside of the leaves, a down, consisting of soft, short hairs, — called pubescence, — the tree may be set down as Red Ash. There is no distinction made in the lumber trade, but there should be, although for many purposes one is about as good as the other. It is mainly in elasticity that the White Ash is superior.

The Red Ash grows in nearly all localities where the White Ash does, with its best development in the Northern States and east of the Alleghany Mountains. West of these mountains it is not so common, or so large, and appears to change in character. At its best it seldom attains a height of over seventy feet or a diameter of over twenty-two inches. It forms an irregularly shaped head when approaching maturity. It is light-demanding and must be

¹ *White Ash*, Circular No. 84.

grown in close stands to produce the best results, although its lower limbs will die as it approaches maturity, even though the tree stands in the open. Its growth is not so rapid as that of the White Ash nor can it be considered a long-lived tree.

The wood in thrifty trees is moderately strong, heavy, hard, coarse-grained, and liable to be brittle. The heartwood is a light brown, with thick sapwood slightly lighter in color and frequently streaked with yellow. It is difficult to distinguish the wood from that of the White Ash by its general appearance, and manufacturers and dealers may be deceived in it. He who desires a piece of tough, elastic timber is the one who will most likely ascertain which it is.

As with the White Ash, the pistillate and staminate flowers are borne on separate trees, and the seeds are almost identical in appearance. The same care should be exercised in securing fertile seeds as is necessary for the White Ash, and propagation should be the same; but as that tree is superior and will grow in nearly all localities where the Red Ash will, it certainly should be chosen in preference. Only in soils too wet for White Ash would good judgment indicate its adoption.

GREEN ASH : *Fraxinus lanceolata*

WHETHER Green Ash is a distinct species is an unsettled question. Professor C. S. Sargent¹ notes that on going westward it is "connected with Red Ash by intermediate forms equally referable to either tree," and this being so, the natural inference would be that it is a modification brought about by soil and climatic conditions, and the probabilities are that such is the case. The principal economic difference is that Green Ash can better withstand the drier and colder climate of the Northwest. There is little difference in the character of the wood and both are

¹ *Manual of Trees of North America*, page 772.

sold as "white ash." In consequence of its hardness, it has a wider range than any other timber Ash. It is widely distributed, ranging from Massachusetts westward to the Continental Divide and southward to the Gulf of Mexico, but it is not very common east of the Mississippi Valley, and it is not to be found at all along the Atlantic Coast from Maryland to southern Florida. It is one of the few trees that will grow in the moist, warm climate of the Southern States and in the cold and dry regions of the North. This adaptableness to conditions makes it one of the most valuable trees for the Northwest, and it is superior to all other Ashes there. Its ability to withstand the rigors of the climate far north of our northern boundary has led to its propagation in the Dominion of Canada hundreds of miles north of Montana. Its cultivation should be along the line laid down for White Ash, and the same care should be exercised in securing seed. There is no reason why it should not be planted where it is too cold or too dry for White Ash. While the wood is not quite equal to that of White Ash, it is a very good substitute.

BLUE ASH: *Fraxinus quadrangulata*

THERE is still another Ash that produces good timber, in fact vies with all others of that family for quality, but it is by no means as widely distributed. It is known as Blue Ash, *Fraxinus quadrangulata*, botanically so called because of the four-angled arrangement of twigs and limbs. It is known in the lumber trade as White Ash, and in this case the purchaser is in no sense wronged, for the quality of the wood is equal to the best White Ash, and probably the average is better.

Its natural range is not fully determined. It may be found from Michigan and Iowa southward to northern Alabama and northern Arkansas. Its best development is on the hills bordering the Wabash River, and on the western slopes of some of the Tennessee mountains. It thrives best

on fertile limestone hills, but can be found on lower but rich ground. It is nowhere abundant.

Sometimes the tree grows to a height of one hundred and fifteen feet, with a diameter of three feet, but such dimensions are unusual. A height of seventy-five feet and diameter of two feet are more commonly found. The thickness of its annual rings shows it to be a fairly rapid grower, especially during the first seventy-five to one hundred years of its life. It is light-demanding, and when crowded throws up a smooth stem, slightly tapering, and free from limbs for more than half its height. In general appearance it closely resembles the White Ash, mainly differing from that tree in the character of its bark and flowers. Its bark is thinner and separates in large plate-like scales, and its flowers are perfect.

The heartwood is strong, elastic, hard, and heavy. In color it is light yellow, mottled or streaked with brown, quite like the White Ash, and with very thick but lighter-colored sapwood. The tree frequently reaches the age of seventy-five or eighty years before any heartwood is developed. It is this sapwood that is deemed of superior quality for carriage-work, for fork, hoe, rake, and shovel handles, and for agricultural implements generally. It is moderately close-grained, and does not show a very marked distinction between spring and summer wood, and its medullary rays are inconspicuous. It is used for substantially all purposes to which White Ash can be put, while its hardness makes it good flooring. It is considered superior to all other Ashes in resisting decay when exposed.

Commercial nurserymen have grown it for ornamental purposes and report no difficulty in doing so. It cannot be learned that any effort has been made to plant it in the forest. No doubt it should receive the same treatment in propagating it in the forest nursery and in removing it into the forest that White Ash demands. There need not be as great care exercised in gathering seed as for other Ashes, for, as stated, the flowers are perfect, and hence the two sexes

are not borne on separate trees or even on separate limbs. Its good qualities will certainly justify earnest efforts to grow it on soils suited to it, and even to experiment with it on other than in limestone regions, for it may thrive on others if fertile.

BLACK ASH: *Fraxinus nigra*

THIS tree stands alone in its class. It is essentially a swamp tree and flourishes best in the cooler sections of the country. Its range is from Maine to Virginia and westward to Minnesota. It will not thrive well on dry ground, and its successful cultivation can be carried on only in its chosen home, and as the location in which it will grow can seldom produce anything better it might be well to plant it there, as its wood is useful for many purposes. Its tendency is to grow tall, frequently reaching eighty or ninety feet in height, with a diameter rarely exceeding thirty inches, but sometimes reaching three feet. When grown in a fairly close stand it has but few limbs on the lower part of the stem, with slender upright ones at the top. "Burls," which may be cut into veneers and used for inlay work, frequently form on the otherwise clean portion of the stem.

The wood is heavy, tough, coarse-grained, rather softer than that of the other Ashes, heartwood dark brown, with nearly white sapwood, and not durable when exposed to the ground. There is a marked difference between the spring and summer wood. There are numerous and coarse ducts in the former which permit the annual layers to be easily separated. This allows it to be split tangentially for hoops, baskets, and chair bottoms. Sometimes the annual layers are darkly veined. They are always prominent. The medullary rays are small, numerous, but not at all conspicuous. Its general use is for cheap furniture and interior finish.

The flowers and fruit are similar to those of the White Ash, except that the seed and wing of the White Ash are

larger. There is no information to be obtained of any effort to grow it for any purpose. Natural reproduction will probably produce all that is required if allowed to take place. It sprouts quite freely from the stump, and reproduction could be brought about in this way, aided by sowing seed in moist places.

THE HICKORIES

THERE are twelve species of Hickories known to botanists and they are all indigenous to North America. None can be found growing naturally elsewhere. Eleven of them belong to the United States, but only four of these are deemed of sufficient value as timber trees to be considered here. Large consumers place them in two classes and speak of them as Shellbark Hickory and Black Hickory, while the lumber trade calls the lumber cut from all of the valuable species "hickory," and by this general designation the consumer will not be wronged if lumber cut from no other species than the four hereafter considered is given him, although the class called Black Hickory is preferred by some carriage manufacturers. Only an expert is capable of distinguishing between the woods. For most purposes all four species are alike very valuable and have no competitors. For light carriage-work there is no rival of Hickory. The beauty, lightness, strength, and superiority of carriages constructed of our best Hickories have never been attained by the use of any other wood, while for handles and all purposes where strength, combined with lightness, is desired, it is unsurpassed. All species rank first-class for fuel. Hickory is also largely used for smoking meat, the United States Forestry Bureau reporting that thirty-one thousand cords, or approximately twenty-two million feet, are annually demanded by the four hundred and seventy-three packing establishments in the United States for smoking meat. This does not include what farmers use for the same purpose, which is quite likely as much more. Unfortunately there has been little or no attempt made to perpetuate the supply of this extremely valuable wood, and carriage-makers are facing a famine in it which will become acute within fifteen years, if not before.

All the Hickories have pronounced tap-roots. This feature seems to be essential, as none are able to overcome its destruction or serious injury. All attempts to transplant the valuable species of Hickory result in practical failures. They may grow in a feeble way for a time, but generally die in a few years, or, if not, never grow vigorously. Of all the Hickories only the Bitternut (*Hicoria minima*) — a tree of little value for lumber and none for fruit — can be successfully transplanted. In consequence of this feature no attempt to grow Hickories in a nursery and then transplant them into the forest should be expected to be successful. The nuts should be planted where the trees are to stand. They should be gathered as soon as ripe and at once planted; or, if not convenient to do that at once, they should be stratified in a box with moist sand and placed in the ground with so slight a covering that freezing may occur, if possible. If thus kept, no time should be lost in planting in early spring. In no case should the nuts be allowed to become at all dry. If that occurs, even slightly, vitality will be impaired if not wholly destroyed.

There are two species in the Shellbark class, Shellbark (*Hicoria laciniosa*) and Shagbark (*Hicoria ovata*). Each of these is indiscriminately called "Shagbark" and "Shellbark" throughout nearly the entire range of their natural habitat, while the former (*H. laciniosa*) should be called "Shellbark" and the latter (*H. ovata*) "Shagbark." There is a botanical difference, but so far as economic features may be considered there is very little if any. The Shagbark has the rougher bark and produces the common hickory nut of commerce. The Shellbark has also a rough bark, but it is less so than the other, and the nut is smaller.

The Black Hickory class is composed of the Mockernut (*Hicoria alba*) and the Pignut (*Hicoria glabra*). There is little difference in the wood of these two trees. Only the former bears edible fruit.

One species of Hickory, *Hicoria pecan*, bears the well-known pecan nut. While practically worthless for timber,

it is largely planted for its fruit in states south of southern Illinois, where the trees are grown from nuts from selected trees or from grafts cut from such trees.

SHAGBARK HICKORY: *Hicoria ovata*

LIKE many another valuable timber tree this one is loaded down with a large number of strange and absurd names, several of which may be heard in localities not widely separated. It is not uncommon to hear it called Shellbark and Shagbark in the same vicinity. It is the largest of the valuable Hickories, only the Pecan exceeding it in size. It is ordinarily found from eighty to ninety feet in height and from twenty-four to thirty-six inches in diameter, while specimens showing one hundred and twenty feet in height, with a diameter of three or even four feet, are not very rare.

Its natural range includes an area bounded by a line drawn from Maine to eastern Nebraska, and south to Texas, thence through northern Mississippi and thence northward to Maine, but not along the Atlantic Coast from Florida to New Jersey. Its best development is along the western slope of the Alleghany Mountains and in southern Ohio, Indiana, Illinois, Kentucky, Tennessee, and West Virginia, but it is a vigorous grower from southern New England to Alabama. It grows best in a rich, moist soil, along streams and around the borders of swamps, but does not show much lack of vigor on low, fertile hills or in moist intervals. The character of the soil seems somehow to affect the quality of the timber in all the Hickories. Studebaker Brothers, manufacturers of carriages, of South Bend, Indiana, write the author that "the best stock is grown only on clay lands with heavy limestone subsoil. Good Oak and Hickory are associated and usually grow of the same quality in the same class of soil, and where Oak is inclined to be brashy and pithy, the Hickory is likewise."

The tree is light-demanding, and when grown in close



GROUP OF HICKORIES — HICORIA GLABRA IN CENTRE, SHAGBARK ON
SIDES. MONTEREY, PUTNAM COUNTY, TENNESSEE

Courtesy of U. S. Forest Service.

proximity to other trees will show a straight, slightly tapering stem, clean of limbs, for fifty, sixty-five, or even seventy feet. In such situations it forms a narrow crown of rather small limbs. Occasionally a few specialized limbs will appear, but they seldom reach large dimensions. When grown in the open, its tendency is to maintain a straight, tapering stem, with many small limbs, frequently pendulous, forming a conical crown. As age creeps on, the lower limbs die and drop off.

The wood is very hard and strong, heavy, close-grained, elastic, and tough. It is generally straight-grained, and can be easily bent for carriage work and like uses. The heartwood is light brown, with thin and nearly white sapwood. The medullary rays are small and inconspicuous, and there is slight difference between spring and summer growth. The wood is not durable when exposed to the weather or soil. It has generally been thought that the heartwood is not as strong as the sapwood. Recent experiments by the United States Forest Service demonstrate that such belief is an error: it has been determined that there is no perceptible difference. The wood is used for agricultural implements, handles, all purposes where strength and toughness are required, hoop poles, baskets, fuel, — for which there is nothing like it, — but most of all for carriage and wagon work, for which it has no equal nor is there any known substitute.

Aboveground the tree grows rather slowly for the first four or five years of its life, but like all tap-rooted trees its roots go deep into the ground for food and moisture, and when these are secured it begins a vigorous stem growth, which it maintains well on towards old age, unless suppressed by other trees, or injured in some way. It sprouts quite freely from the cut stump when young, but seldom throws up any sprouts after reaching six or seven inches in diameter. This feature of sprouting when young makes cutting hoop poles profitable in some localities. Frequent cutting, however, enfeebles the root system, and it ceases

to produce a good growth after two or three cuttings have been made. If allowed to grow it is seldom that a sprout reaches a size large enough for a sawlog before decay sets in. It is a fairly good seeder, and its fruit is promptly seized by squirrels, mice, and mankind; and when these consumers are at all numerous, there is little chance for natural reproduction. As the tree bears fruit quite early, — sometimes when only thirty years old, when growing in the open, — obtaining seed need not be a difficult task, if existing trees are cared for. The nuts should be planted six feet apart and the trees thinned as conditions indicate. The young growth being superior for handles, there will soon come a return for the money invested. Like the Black Walnut, the tree is profitable for both wood and fruit.

SHELLBARK HICKORY: *Hicoria laciniosa*

THIS tree closely resembles the Shagbark. In some localities it is known as the King-nut. Its form and habit of growth are quite similar and the quality of its wood is practically the same. Its range, however, is less in extent, it being seldom found north of central New York or east of the Alleghanies. Neither does it extend as far south as the Shagbark. Its western limit is about the same. It also prefers a moist soil, being partial to rich bottom lands which are sometimes flooded in spring. Probably its best development is near the large swamps and lowlands of the lower Ohio River basin and in central Missouri. It is one of the most common trees to be found there.

The tree does not attain as great a diameter as the Shagbark, seldom exceeding three feet, but in height and general characteristics of stem and crown, it is substantially the same. The heartwood is somewhat darker than the Shagbark, but the sapwood is thin and nearly white. The wood is used for the same purposes. The casual observer can distinguish between the trees mainly from the

larger scales of the bark of the Shagbark, these frequently being three or four feet long, quite broad and thick, and more or less seamed vertically.

The nuts are larger than those of the Shagbark, and the shell is thick and hard. They are edible. Caring for seeds and propagating should be the same in all respects as for other Hickories. As it naturally thrives in ground frequently inundated for several weeks in the spring of the year, such locations should be chosen in which to grow it, especially as no other Hickory will thrive as well there; but it will grow fairly well elsewhere if the ground is fertile.

MOCKERNUT HICKORY: *Hicoria alba*

SURELY this tree has more than its share of names. There are fifteen in all, some of which are absurd and uncouth. Mockernut is the one most generally chosen and it is quite appropriate, intended, no doubt, to express the disappointment and disgust in the mind of any one who may think he has a large edible nut, but finds the seed very small. It is sometimes called "Big-bud Hickory," a name entirely in keeping with its peculiar winter buds.

Its range extends farther south than any other Hickory that is valued for its wood, even reaching to the Gulf of Mexico. It may also be found as far north as Lake Ontario, but it is comparatively rare in the Northern States. Its best development is in the Ohio River Basin and in Missouri and Arkansas. In the South it is most common on sandy hummocks, but along the Gulf and in the South Atlantic States it is abundant on low ground next to the shores of bays and inlets. In the North it is mainly confined to low ridges. It appears to prefer soil that never becomes very dry, although it may not be very fertile. Still, fertility is essential to a vigorous growth, and this is true of all the Hickories.

Little need be said concerning the general characteristics of the tree, for they do not essentially differ from those

of the other Hickories. It does not grow very tall, seldom reaching one hundred feet, — generally not over eighty-five, — and rarely attaining a diameter of three feet, usually not over two feet. Like the other Hickories it is light-demanding, and when crowded will send up a straight stem, clean, tapering, and free from limbs for one half its height.

The wood is much like that of the Shagbark class, except that the heartwood is dark brown, and there is a thick and nearly white sapwood. This latter feature is responsible for its botanical designation, — *alba*, or white. In every respect the wood is equal in quality to that of the other Hickories, and the large percentage of white sapwood has, no doubt, caused consumers to prefer it to any other, although there is doubt if that feature adds anything to its value.

As indicated, its fruit is practically valueless, owing to its thick shell and small size of kernel, — although it finds a ready sale with those who are not familiar with its character, — hence it must be grown for its wood alone. The nuts should be gathered and treated the same as noted for other Hickories and propagation be carried on along the same lines.

PIGNUT HICKORY : *Hicoria glabra*

AN absurd name seems to have been reached in the first attempt in the case of the Pignut Hickory, although it is called by several other names, frequently "Bitternut," which is both incorrect and confusing. It is not even a variety of *H. minima*, although, like that tree, it bears bitter fruit. Its range is from Maine southward to the Gulf States, and westward to eastern Kansas. It is most abundant in Missouri and Arkansas, and its best development is in the lower Ohio River basin. It prefers dry ridges and hillsides.

The tree seldom reaches ninety feet in height, more generally not over seventy-five. It is occasionally found three to three and one half feet in diameter, although it does not often exceed two feet. Demanding light, it sends up a slender stem, clean of large limbs, and forms a crown with

quite frequently crooked branches, but none of them greatly specialized. Accident or the formation of two terminal buds causes the tree occasionally to fork and form a double top. This happens more frequently with this than with any other Hickory.

There is practically no difference between the wood of this tree and that of the other Hickories described. It has a thick and nearly white sapwood, while the heartwood is a light brown. It is a good seed-bearer, and the same treatment should be given for its propagation as for that of the other Hickories. The nuts are variable in form, with small, bitter kernels, although in some localities not greatly so. As with the Mockernut, the tree must be cultivated for its wood alone. Its great value as a timber tree will justify that. All the Hickories should be planted six by six feet apart.

No doubt there are some Hickories not here mentioned that may serve fairly well for many purposes, especially for fuel, but the important ones have been considered.

THE MAPLES

THE family of Maples is a large one. There are between sixty and seventy species in the world — all but one of them belonging to the Northern Hemisphere — and thirteen of them indigenous to the United States, of which less than one half have any commercial value as timber trees. They are naturally separated into two classes: Hard Maple and Soft Maple. This division is based upon the physical characteristics of the wood of each, and it has been very properly adopted by the lumber trade.

While there are several species belonging to the Hard Maple class, there are but three that may be considered as rightfully belonging to the list of important timber trees of our country. These are Sugar Maple (*Acer saccharum*, sometimes called "Sugar Tree," "Rock Maple," and "Hard Maple"); Black Maple (*Acer nigrum*, generally called "Rock Maple"); and Broadleaf Maple (*Acer macrophyllum*, frequently called "Oregon Maple"). The last-named one is elsewhere described (page 354) when considering the broadleaf trees of the Pacific Slope.

Of the Soft Maple class there may be named Silver Maple (*Acer saccharinum*, generally called "Soft Maple"), and Red Maple (*Acer rubrum*).

SUGAR MAPLE: *Acer saccharum* and *nigrum*

BECAUSE of its widespread natural range, the well-known Sugar Maple is the dominant one of the Hard Maple class; but the economic difference between this and the Black Maple is not great. What there is lies in the smaller size of the Black Maple and the slightly greater hardness of its wood. Both species may be accurately called Sugar Maple, but if either deserves the name of Hard Maple, it more

consistently belongs to the Black species. As the habits of growth are almost identical and the methods of propagation entirely so, a consideration of the Sugar Maple will serve equally as well for the other and hence that plan is adopted.

There is probably more diversity of form and habit with the Sugar Maples than there is with any other species of timber trees. In a plantation of fifty-one trees, about twenty-five years old, on the author's grounds, growing mainly in the open, there can be seen nine different forms of crowns, leaves, or bark. Still, they are all Sugar Maples, with not enough difference even to justify classing them as distinct varieties. There will be no difference in value of wood when cut.

The natural range is along our northern border from Maine to Minnesota, south, through the Northern States and on the Alleghany Mountains, to northern Georgia and western Florida, and west to eastern Kansas and eastern Nebraska. There is a somewhat modified species in the Carolinas, northern Georgia, northern Mississippi, and some of the other Southern States, the wood of which is softer than that of the northern tree, and for hardness lies between that and the Soft Maple. The region of the best development of the Sugar Maple is central New England, New York, Pennsylvania, and the Great Lake states. Trees from one hundred to one hundred and twenty feet high and four feet in diameter, sometimes showing a stem fifty or more feet without a limb, are not at all uncommon. It flourishes best on well-drained soils, but thrives fairly well where the soil is not rich, if it is not too wet. It is most frequently found on low ridges, along the slopes and base of mountains and hills, and also on moderately dry intervals. It can endure some shade, but if grown in the open, it assumes a somewhat low, spreading, round, and quite dense crown. If grown in a close stand, it will send up its stem until sufficient light is obtained and then branch into a round crown with large limbs.

The wood is heavy, hard, strong, close-grained, generally

straight-grained, and quite tough. The heartwood is usually a grayish brown, tinged with red. The sapwood is white and may have from twenty-five to even fifty or sixty annual rings. It is not unusual for a thrifty tree to reach the age of fifty years before any sapwood is formed. There is little distinction between spring and summer wood; the medullary rays are numerous, but small and inconspicuous. For some unknown cause the grain is sometimes contorted and mottled with little spots or knots, possibly undeveloped or adventitious buds. Such wood is known as "Bird's-Eye Maple." When the grain is contorted into waves it constitutes what is known as "Curled Maple." In the latter the waves are quite uniform and evenly repeated. Both these features—especially the former—add much to its value for cabinet and interior finish. Even when the fibre is plain, it is largely used for these purposes, and, fortunately, fashion does not dictate that it shall be tarnished with stain. It takes glue well and when well seasoned is little affected by moderate changes of humidity in the surrounding atmosphere. Flooring manufactured from it has no superior if an equal for hardness and durability, and it is largely used for halls and other public rooms. It is also used for shoe-last, turnery, handles, and many other purposes where hardness and fine finish are demanded. It is not durable when exposed to the weather or soil. It is an excellent fuel and the resultant ash is rich in potash. When the forests were cut down to clear the land for farms, it was a common practice to save the ashes, where the logs were burned, from Maple and a few other hardwoods, leach them and boil down and calcine the lye in large cast-iron vessels called "potash kettles," when the product would be an impure carbonate of potash commercially known as "pearlash."

Only from the Birches is there so copious a flow of sap as from the Sugar Maple of the Northern States. If the sapwood is wounded in late autumn the flow sometimes manifests itself after a cold night that is succeeded by a



SUGAR MAPLE

Photographed by J. Horace McFarland.

warm day, but the flow is greatest in late winter and early spring, ceasing as the buds swell. The trees are "tapped" and the sap gathered and evaporated, producing the well-known delicious maple sugar and syrup, a large amount of which is annually manufactured in the Northern States. The three or four outer annual layers of sapwood yield nearly all the sap, which contains more saccharine matter than flows from any other tree except Hickory, from which latter tree, however, there is a very slight discharge.

It is a prolific seed-bearer after the age of thirty-five or forty years, but seldom produces any before that. The seeds ripen early in autumn and are so well known that a description of them is not worth while. They should be gathered as soon as ripe and stratified in moist sand — but by no means very moist — and kept in a cool place where they will not dry out. Freezing will not injure them. They can be sown in the seed-bed in late fall or early spring. Unfortunately the percentage of fertility is low, frequently not averaging twenty-five per cent; hence they should be sown thick enough to compensate for that. At three or four years of age the plants can be transferred to the forest. It is doubtful whether transplanting in the nursery will pay, as the tree does not have a tap-root and has many fibrous ones. Only strengthening the root system would justify it. It is not at all difficult to transplant. Plants can be frequently secured in the forests, where they may be found under the parent trees, and where, unless removed, they will eventually die from want of light.

The tree is a moderately rapid grower after four or five years of age. In the Southern States, however, it makes a rapid growth from the very first. The tree lives to an old age, and in the forest is seldom seriously affected by insects or disease; but in the open it sometimes is attacked by a species of borer. No information can be obtained of any attempt to grow it for lumber alone, — although largely planted as an ornamental tree, — but it can be safely assumed that it will thrive when set out in proper situations.

The distances apart at which the plants should be set should be from five to six feet, according to the character of the soil. As an ornamental tree it has no superior and few equals, but it cannot endure the smoke and dust of the city streets as well as the Oriental Plane and Norway Maple — both foreigners.

SILVER MAPLE: SOFT MAPLE: *Acer saccharinum*

THIS tree belongs to the Soft Maple class and is widely distributed throughout the United States, although seldom found near the Atlantic Coast. While it is known by some ten different names, it is generally called Silver Maple, from the silvery sheen of the underside of its leaves, and Soft Maple because its wood is softer than that of the Hard Maple. It is very variable both in form of growth and character of the lumber it produces, brought about, no doubt, through climatic and other conditions. There are two distinct varieties, besides several lesser ones — the latter not here considered. One has an open crown, with long, slender limbs, sometimes specialized, and with quite large indented leaves. This variety has large seeds. The other has a more compact crown, with limbs of moderate length, rather small leaves not deeply indented, and small seeds. The former is the more rapid grower. Both are light-demanding, and in a dense stand will grow to a height of eighty or ninety feet, with a diameter of three feet. In the open, they develop a straggling crown, with specialized limbs, and a stem of four feet in diameter next the ground. The similarity of the two varieties is so great that they will be here considered as identical.

Its best development is along stream banks where the soil is moist and rich. In such situations it grows to its greatest size. It does not attain a large size in high and dry situations, notwithstanding that it will persist, in some localities, in attempting to grow there. It is a nuisance in some places in the East, especially on high, dry, cut-over

lands. It is an early and prolific seed-bearer and the seeds are readily scattered by the winds. Being a rapid grower when young, it shuts out or suppresses more valuable species. If injured in any way it is liable to throw up sprouts which never attain a large size. All this, however, gives it a value for the farmer's woodlot, and it is quite extensively planted in the prairie states, and farther west, for that purpose.

The wood is moderately hard, but by no means as hard as that of Hard Maple. It is strong, close-grained, easily worked, but rather brittle. The heartwood is generally a dark brown—sometimes an umber color—and the sapwood is nearly white and very thick. A tree seldom develops heartwood before the age of fifty or sixty years. The sapwood is sometimes used for flooring when combined with some darker wood. Lumber cut from the tree is used for cheap furniture and many other purposes where not exposed to the ground or weather. It is especially adapted to turnery and is used for paper pulp. It is not a first-class fuel, but answers a fairly good purpose if well seasoned.

It blooms in early spring and before the appearance of the leaves. The seeds, as soon as ripe, should be promptly planted, and in fairly good ground may be expected to make a growth of a foot or more the first year. The staminate blossoms may be on one tree and pistillate ones on another, or both on the same tree. If the latter is not the case, there is great danger that the seeds will be infertile. It is not a difficult tree to grow in the nursery or transplant into the forest. It may be set in the forest when one year old, but would better be left in the nursery another year. Its flow of sap is abundant, but it is low in saccharine matter. The trees should be planted from five to six feet apart.

RED MAPLE : SCARLET MAPLE : *Acer rubrum*

THIS tree is very common, and but few are as widely distributed east of the Mississippi River. Its red twigs, red blossoms, and early red autumn leaves make it quite distinct from the Silver Maple, although in some localities its general appearance is such as has led to a confusion in the mind of the casual observer. Its natural habitat, however, is in moister ground ; in fact, it is practically a swamp tree, although, like the Silver Maple, it, in some localities, proves itself a pest, and for the same reasons. Its wood is substantially the same as that of the Silver Maple and is used for the same purposes. No distinction is made in the market. Both are sold as "Soft Maple," and no one is wronged. If its cultivation is undertaken, it should be along the same lines as for Silver Maple, except that the ground chosen should be moister and more care exercised in gathering seeds, for it is more given to produce pistillate flowers on one tree and staminate on another. It blossoms early in the spring, — in some localities earlier, if anything, than the Silver Maple, frequently in March ; the seeds are ripe in May and should be promptly gathered and sown. Like the Silver Maple it is a rapid grower, especially in early life, and can be removed into the forest when only one year old, and like that tree it is a fairly good fuel ; its cultivation for that purpose alone would be warranted, especially on ground too wet for better species ; but the cultivation for timber of neither the Silver nor Red Maple would be justified anywhere if better species can be grown in the same locality.

YELLOW POPLAR: TULIP-TREE:

Liriodendron tulipifera

THIS valuable tree is generally called Yellow Poplar, or, less frequently, Tulip-tree. The latter is the most appropriate name, for it is not a Poplar at all. It is one of the only two remaining representatives of many species which grew in long-past geologic times. One of these is indigenous to this country and the other to China. Notwithstanding that it is burdened with fifteen different names, — unmeaning and foolish, — it is generally known in the lumber trade as Yellow Poplar. In some localities, however, the heartwood is nearly white and softer than in other regions, and to distinguish such from lumber generally cut from the tree, it is designated as White Poplar, or, more frequently, Whitewood. Just why the heartwood is nearly white in some localities and light yellow in others is not well understood; but it probably arises from a difference in soil or climatic conditions, as there is but the one species here.

A line bounding its natural range runs from Massachusetts west to southern Illinois, thence south to eastern Arkansas and western Mississippi to near the Gulf of Mexico, from there to southern Georgia and along the Atlantic Coast to Massachusetts. It is the most abundant and of the best development in the valleys tributary to the Ohio River, and on the slopes of the mountains in North Carolina, Tennessee, Kentucky, and the Virginias. At their best Tulip-trees have been found ten feet in diameter and one hundred and forty feet high. Trees from three to five feet in diameter are not at all exceptional in virgin forests. It is not found in pure stands, but is mingled with other broadleaf trees, seldom among Pines and Hemlock.

It is decidedly light-demanding, and when grown crowded will push up a smooth, straight, moderately tapering stem,

until it fairly overcomes its competitors for light, frequently showing in adult trees seventy-five or more feet without a limb. When it attains a mastery in the struggle for light, it will develop large limbs instead of increasing in height; but if overtaken by its neighbors, and the contest is renewed, it will again mount upward and leave its ambitious large limbs to care for themselves or die. These will, in time, die and drop off, and decay in the main stem is likely to follow. When growing in the open, it forms a conical crown, the lower limbs reaching out so far that the base of the cone is nearly, or quite, as great as its height. Its leading shoot, however, maintains its ascendancy and a forked tree is seldom seen. Here, as well as when growing among competitors for light, the foliage will mainly be found at the outer ends of the limbs, where it forms so dense a covering that the twigs and small limbs there will die.

The wood is soft, straight-grained, easily worked, not strong, and is more or less brittle according to age. It takes glue, stain, and paint well, no wood except White Pine rivaling it in the latter feature. In most trees the heartwood is a light yellow or brown, with thin, creamy sapwood; but, as stated, in some sections the heartwood is nearly white, though not strictly so. There is little distinction between spring and summer wood. The medullary rays are small and inconspicuous. It is not durable when exposed to the ground. It is used for interior finish, furniture, and nearly all purposes for which White Pine is fitted.

Unfortunately its propagation is difficult, owing to the fact that not over ten per cent, if so much, of its seeds are fertile, and it has fleshy roots with few fibrous ones, and, hence, is difficult to transplant successfully. It bears seed in great abundance and when quite young. One thirteen years old produced seed and has continued to do so for three successive years, although not abundantly until the last year. It sends up shoots from the crown of the roots. Sometimes these make a strong and healthy tree suitable for the saw.



YELLOW POPLAR (TULIP-TREE) (IN CENTRE)

It is forty inches in diameter and shows about seventy-five feet of stem. Jefferson County, Pennsylvania.



TULIP-TREE, GROWN IN THE OPEN, SIX FEET IN DIAMETER. MONASKON, VIRGINIA

Courtesy of U. S. Forest Service.

It was claimed a few years ago that the tree could be propagated from cuttings the same as the Poplars and Willows. Repeated and varied efforts to grow it in that way have proved complete failures. Except such few as may come from sprouts, growing the trees from the seed must be the only method of propagation. The seed ripens in the early fall, but the cones do not open until the leaves are shed. As soon as the leaves turn yellow, the cones may be gathered, and when dry the seeds will fall from the cone stem. They would best be sown in the fall; but if not they should be stratified in sand and kept in a cool place, one dry enough to prevent moulding, yet damp enough to prevent drying-out, and then be sown in the spring as soon as the ground will permit. It frequently requires two years for the seed to germinate.

Yellow Poplar is remarkably free from insect enemies or disease of any kind. Decay of the stem from dead limbs is about the only malady affecting it. It should be added that great care has to be taken in felling large trees, because of their liability to break when they strike the ground. It will grow in almost any fertile soil, if not too wet, and even in one so sterile as to be of little use for agriculture. Some fine specimens were found on the mountains of Pennsylvania, where the ground was ill fitted for cultivation because of lack of fertility; yet the tree will show high appreciation of a generous soil to grow in. Seedlings attain a height of about six inches the first year; after that, the tree is a rapid grower until it reaches maturity. In order to secure fibrous roots, the seedlings would best be transplanted into the transplant nursery when one year old and remain there two years, when they will be strong enough to hold their own against their surroundings in the forest.

Lumber cut from good trees stands among the Softwoods next in value to White Pine, and no effort should be spared to assist natural reproduction, — which is fairly good, if permitted, — and artificial cultivation should be undertaken notwithstanding the drawbacks.

CHESTNUT : *Castanea dentata*

IF our timber trees were classified according to their economic importance and the profits which may arise from their cultivation, there is no doubt but that the Chestnut should be placed high in that list. It has been spared the infliction of a multitude of names. Only the red man ever deigned to call it anything but Chestnut. As always, he gave it a significant appellation — “O-heh-yah-tah,” meaning prickly burr. Under favorable conditions it is long-lived and grows to a large size. There are well-authenticated records of its having reached a diameter of eleven feet, but such a growth was found only in trees standing more or less in the open, and which did not attain a great height. When grown in a crowded situation, it has been known to reach a height of over one hundred feet, with a diameter of seven feet. The average size of mature trees in a virgin forest, on ground not too dry, is between twenty and thirty-six inches in diameter, and eighty to one hundred feet in height. When found above two feet in diameter, it is quite frequently worm-eaten. When grown in close stands, it will produce a tall, straight stem, free from limbs for two thirds of its height, with slight taper; but when grown in the open, it forms a low, round, but somewhat irregular crown, and frequently has specialized limbs.

It may be found from the southern part of Maine to Georgia, and from the Atlantic Coast westwardly to the Mississippi River, thence north to northern Michigan, and eastwardly through that state and on through New York and the New England States. Its best development is to be found in New England, New York, Pennsylvania, Maryland, the west portion of the Virginias, North Carolina, and Tennessee. South of the Potomac River it is best at an elevation of about two thousand feet above the sea. It accepts

a variety of soils, — but not wet ones, — ranging from loose sand and decomposed shale to dry, rocky ridges and mountain slopes, but does not take kindly to limestone land. Neither does it demand a high state of fertility. It is a rapid grower until it reaches sixty or seventy years of age, when its lessening powers of growth become manifest in the gradually diminishing thickness of the annual rings; yet, if not injured, it still retains enough vital force to maintain a moderate growth for centuries. Careful counting, in widely separated sections of the country, of the annual rings in hundreds of telegraph and telephone poles, whose length was forty feet, with a top diameter of not less than six inches, showed that their ages ran from forty-three to sixty-seven years, averaging a trifle over fifty-six.

The wood is light, soft, coarse-grained, quite strong in young trees, but weak in old ones. Young growth is liable to warp and check when seasoning, but this can be avoided by proper piling. It splits easily, and in former times was much used for fence rails. It is durable when exposed to the weather or soil. The heartwood is a light reddish brown, with light-colored sapwood which seldom exceeds eight annual layers.* There is a notable difference between spring and summer wood, and consequently the annual layers are very distinct and prominent. The medullary rays are scarcely discernible to the naked eye. Until within the last fifty years it was little used except for fence posts and fence rails. Now it is largely consumed for all sorts of posts entering the ground, and for railroad ties, interior finish, furniture, shingles, and general construction. Old and worm-eaten Chestnut is largely used for burial caskets, foundations for veneers for doors and panels, piano cases, and other like work; such wood being especially valuable for that purpose, as it neither shrinks nor warps when packed up, and takes glue well. Beyond all this, it is now largely used to furnish tannic acid for the tanneries, the whole tree being employed for that purpose, and large areas are being denuded in consequence.

Propagation can be carried on by sprout growth or by seeds. Above all others of our valuable timber trees, Chestnut can best be depended upon to reproduce itself from sprouts. Other species will quite frequently throw up sprouts from the stump when the tree is cut, but none so uniformly or vigorously. If the stump is cut low, the sprouts will throw out roots and, in a measure, develop an independent root system. Old trees will proportionally send up more sprouts than young ones, but they will not be as vigorous. It is true that sprouts seldom attain sawlog size, but they will reach pole and tie dimensions if the root system has not been exhausted by frequent fires or cuttings. While we have had but little experience in repeated harvesting of sprout growth, observation shows that the root system of such growth is enfeebled by successive removal of the sprouts, and that eventually seed-planting must be resorted to if the forest is to be maintained in perpetual vigor and productiveness. It must be patent to every one that all superfluous sprouts should be removed in order to allow a vigorous growth in the few that are allowed to remain. The number left must be determined by conditions. If the original stand was dense, few should be permitted to grow, but there must be enough left to compel a tall and straight growth and develop a satisfactory forest floor.

Propagation from seed is not at all difficult if rightly conducted. The tree is a prolific seed-bearer, and, moreover, bears seed when quite young, — frequently at the age of ten years, — and there is seldom any difficulty in securing a supply. It blossoms late in June or early in July, and the seed is ripe about the first of October, hence seed-bearing is not likely to be interfered with by frosts. The prickly envelope, commonly called burr, inclosing the seed, is too well known to demand a description. The nuts should be gathered as soon as they fall out of the burrs, and be at once planted where the trees are to grow in the forest, or stored away where they will neither dry nor become heated or mouldy. There are but few valuable



CHESTNUT

Photographed by J. Horace McFarland.



timber trees whose seed is so susceptible of injury as the Chestnut. Any drying, heating, moulding, or even wilting, will affect their vitality, and the sooner they are put into the ground after they are ripe the more certainty there is of success ; hence fall planting should, if possible, be carried out. Fall planting has only one drawback — the liability of squirrels and mice digging up the nuts. If fall planting is not adopted, then the nuts should be stratified with sand, which must be moist but not very wet, and kept out of doors where they will be cool. Freezing will do no harm, but will be beneficial if the sand does not become dry. Planting where the trees are to grow is urged because they have a prominent tap-root which seriously resents being interfered with, although there are laterals thrown out in early life which attain a large size in old age. But for all that, it is a deep-rooted tree, and it is seldom that one is blown down by the wind. It does not throw out lateral roots, however, until too large to be always successfully transplanted. By removing into the transplant nursery when one year old and carefully handling them, a portion can be made to grow, but it takes a long time for them to recover from the shock and become vigorous, an event which seldom occurs.

It is light-demanding, and close planting is certain to cause it to grow tall and straight, and drop its lower limbs, and that system should by all means be adopted. But little planting of Chestnut for timber-growing has been done in this country, and no exact rule can be laid down for the distance apart that the young trees should be planted, but it will be safe to place them from five to six feet, and as soon as they become large enough for posts and poles, thin out as conditions may indicate.

Its abundance, coupled with its ability to reproduce itself, has enabled it to meet fairly well the demand made upon it, but the great variety of uses to which it is now being put will soon cause a very rapid shrinkage in supply, and the promise for the future is not bright. Until re-

cently, Chestnut has suffered little from insect attacks or diseases of any sort, except that it is liable to be worm-eaten when old ; but in 1905 a fungus disease appeared on the trees on Long Island, and from there it has extended into Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, and Delaware. It is very contagious and fatal. No tree has been known to recover when once attacked, and there is no known remedy, and none may ever be found. Borne on the winds and the feet of birds, or by insects, the spores of the fatal fungus lodge in every crevice and crack in the bark where it is possible for them to find their way into the living tissues of the cambium layer, whence it extends to the entire tree. The spores multiply with wonderful rapidity, and the end of the tree's life is soon reached. In some cases the tree dies the first year, and but few survive the second. It is a very serious matter, and may rob the country of one of its most valuable timber trees. Pennsylvania has appropriated two hundred and seventy-five thousand dollars to combat it. A convention was held at Harrisburg, February 19, 1912, to provide for concerted action to suppress the malady. It was attended by over two hundred delegates, representing not only the forestry departments of several states and the United States Forest Service but also the New York Agricultural Experiment Stations and such educational institutions as Yale, Harvard, Cornell, Lehigh, and Pennsylvania universities and the Pennsylvania State College. Little hope was held out that a remedy could be found. All that is being done thus far — aside from ascertaining the boundaries of the disease — is confined to cutting down infected trees and burning all parts not used for lumber or other purposes. The fatality of the disease and its rapid spread indicate that planting would not be advisable, certainly not until a remedy can be found.

BLACK CHERRY: WILD CHERRY: *Prunus serotina*

IN most sections of our country people have been content to call this tree by the above names — mainly the first. In two states, however, it has been given the name of Rum Cherry, quite suggestive of the use to which the fruit is now and then put in adding flavor to certain alcoholic beverages. In the lumber trade it is designated as "Cherry," and as it is the only species out of a half-dozen in this country from which lumber is cut, there can be no criticism. But the same cannot be said of the furniture manufacturer who stains the several species of Birch and palms them off as Cherry; or, if his conscience rebels, will give them the name of Cherry Birch. It is true that the heartwood of old Black Birch trees much resembles in color and appearance Black Cherry, and if the Birch did not warp and spring when subjected to changes in humidity, it would serve as a fair substitute.

The natural range of Black Cherry covers quite the eastern half of the United States, — practically all east of the one hundredth degree of west longitude, — but it is not common along the coast region. It reaches its best development along the northern portion of the Appalachian Mountains. Probably the largest and best trees were found on the slopes and along the streams of the Alleghanies. Trees one hundred feet high and four or five feet in diameter were often found there, although the average diameter of mature trees did not much exceed two feet. Grown in the open, it branches out low down, and, as years go on, large specialized limbs are formed and the tree is practically worthless for lumber; but forest-grown, it shoots up a tall, smooth, straight, and slightly tapering stem without limbs for more than half its height.

As it was found growing on rich alluvial soils and fertile slopes, it suffered destruction in early days for the same reason that Black Walnut did, — it was in the way, — and like that tree it was burned or split into rails. It was soon discovered, however, that it was one of the best woods for furniture. In early times it was used more for that purpose than Black Walnut, and to-day it stands second for such uses only to that tree among our native woods, while in the minds of many it is not deemed inferior; but like that tree it is close on to extinction.

It thrives best in a moist, rich soil, although it will grow quite well on a dry and loamy one which is neither fertile nor moist. To aid its growth in such soils, it has a large root system which runs deep into the ground, and it likewise throws out large and long lateral roots near the surface. In soils adapted to its best development, it is a rapid grower in early life, but as age advances its annual accretions grow less and less, even under the most favorable surroundings. Unless the situation is suitable, it soon begins to show signs of declining vigor and is then not a long-lived tree, but when the soil and surroundings are acceptable, it has been known to reach three hundred years of age. It was nowhere to be found in great abundance, but was mixed with other broadleaf trees, with occasionally a grove of a score or more of its own kind within a radius of a few hundred feet.

The wood is light, easily worked, fine-grained and strong in young trees, but somewhat softer and weaker in old ones, straight-grained, with little difference between spring and summer wood, and with small and inconspicuous medullary rays. The heartwood is reddish brown, with thin, yellowish sapwood which seldom consists of over ten annual layers. It does not warp or split in seasoning, and "stays to its place" when put in trying situations. It takes glue well, and has a fine satiny finish and grows darker and richer in color with age. Its use is mainly confined to furniture, the interior of passenger cars, interior woodwork generally, and



BLACK CHERRY, NORTH CAROLINA

Courtesy of U. S. Forest Service.

to other cases where wood is wanted that will neither warp nor shrink. Young and vigorous trees have lasting qualities when exposed to the ground, and railroads are paying as much for black cherry ties as for white oak. It has long been used for fence posts, and this has led to the destruction of much young growth.

The tree is a good seeder, and there is frequently a large yield of fruit, the pulp of which has a sweet, aromatic taste. It has been known to bear fruit in the open at seventeen years of age. The seed proper is small with a hard shell, like that of all Cherries, and natural seed-sowing is almost entirely carried on by birds dropping them, although squirrels and mice aid to a limited extent. Notwithstanding that the tree has a tap-root, it can be safely transplanted when young; hence it is entirely suitable for nursery propagation. If the young plants are vigorous, they may be removed to the forest when two years old but would best be transplanted into the nursery when one year old, remaining in the transplant nursery for two years, then to be set out in the forest. The fruit ripens about the first of September and should be at once gathered and cared for. If there is no danger of squirrels or mice destroying them, the seeds should be planted in the nursery at once. In such cases the pulp may be left on, although its removal will allow the seeds to be planted with a drill. If the planting is to be delayed until spring, then the pulp should be removed and the seeds should be stratified in moist sand and stored away where they will remain moist, but, if possible, be subjected to freezing, and then planted as early in the spring as possible. They should be placed in rows about eight inches apart and covered from three eighths to one half inch deep, and thereafter be treated the same as other broadleaf seedlings. In no case should the seed be allowed to become dry. The seedlings ordinarily make a growth of six inches the first year, and if not removed may grow eighteen or twenty inches the next.

As the tree is somewhat capricious in choosing its loca-

tion, care should be taken in selecting ground for its cultivation, notwithstanding the fact that it will grow in many soils and that its botanical range seems to be great. Old residents can still be found to tell where it once grew to perfection, and no mistake can be made if such locations are chosen. When planted in the forest there should be a crowded stand, either with its own or other species of equally rapid growth. It lives to a greater age when so surrounded than when out in the open. It is naturally associated with Beech, Oak, Hickory, Maple, Birch, and Yellow Poplar, but it is a more rapid grower in early life than any except the Poplar.¹

In suitable situations and when cared for, there can be few more valuable trees found ; but with all its good qualities it has some drawbacks. One is a caterpillar that makes its nests in the branches and sometimes entirely denudes the tree of its leaves. Another is what is called "gum specks." These are deposits of gum in the wood which sometimes disfigure it to a slight extent. When wounded the sapwood will exude a gum something like gum arabic. It has bitter aromatic bark and leaves. These contain the well-known poison called prussic acid. Cattle have been

¹ The United States Forest Service (*Notes on Forest Trees suitable for planting in the United States — Black Cherry*) gives the following account of the growth of two plantations : —

"In a block planted in 1878, containing 196 White Ash, 27 Catalpa, and 7 Black Cherry trees, the Cherry, when measured in 1901, was the largest, both in diameter and height. The following was the average size of the trees : —

Average diameter at 1 foot from the ground	8.4 inches
Average diameter at 7 feet from the ground	6.4 inches
Average height	34.0 feet
Average clear length of bole	19.0 feet

"In another block containing 149 Black Cherry and 187 Catalpa trees, the latter were entirely dominated by the Cherry. The average size of the Cherry was : —

Average diameter at 1 foot from the ground	5.6 inches
Average diameter at 7 feet from the ground	4.0 inches
Average height	32.0 feet
Average clear length of bole	19.0 feet

As the Catalpa is a notoriously fast growing tree, it would seem that planting Black Cherry in pure stands would be advisable.

poisoned from eating the withered leaves, and children made ill by eating large quantities of the fruit — the poisonous element being the same as in peach seeds. There is considerable use made of an extract of the bark in pulmonary complaints.

THE ELMS

THERE are four species of Elms indigenous to the United States that have a commercial value. They are commonly known as White Elm (*Ulmus americana*), Red Elm (*Ulmus pubescens*), Cork Elm (*Ulmus racemosa*), and Cedar Elm (*Ulmus crassifolia*); but their names are woefully mixed in some localities. There is little economic difference in the value of the wood, and few consumers are able to distinguish the lumber cut from them, and it is doubtful if many dealers can distinguish them. For many purposes there is little choice; none are suited for general, but all are admirably adapted for special uses.

WHITE ELM: GRAY ELM: *Ulmus americana*

BEYOND question this is the most common and widespread of all the Elms. It is of extended range, reaching from the foothills of the Rocky Mountains eastward over every state and more or less scattered throughout the entire area. It is the largest of the Elms and probably produces more lumber than all the rest, — at least, it has done that heretofore, — and for most purposes the lumber is as good as that of the other species. The tree grows to an enormous size and lives to a good old age. Professor C. S. Sargent,¹ in speaking of it, says: "A tree, sometimes one hundred to one hundred and twenty feet high, with a tall trunk six to eleven feet in diameter, frequently enlarged at the base by great buttresses, occasionally rising with a straight undivided shaft to the height of sixty to eighty feet and separating into short spreading branches." This is an excellent description of many a forest-grown Elm.

The trunk of a White Elm that grew in Jefferson County,

¹ *Manual of the Trees of North America*, page 289.



WHITE OR GRAY ELM, CHARLEVOIX COUNTY, MICHIGAN

Photographed by American Lumberman, Chicago, Illinois.

Pennsylvania, and which inexcusable vandalism destroyed, was five feet in diameter above the buttressed base and thirty-six feet to the first limb, where it was a trifle over four feet in diameter. From the stump to the topmost part of the crown was one hundred and forty feet, and it spread its branches seventy-six feet. The stump showed three hundred and twenty-eight annual rings, and it was sound to the pith. The logs cut from the tree scaled 8820 feet, board measure. Until the last twenty-five or thirty years the tree had stood in a dense forest of mainly Beech and Sugar Maple, and had towered fully fifty feet above its neighbors.

The best development of the White Elm was found in the New England States. Doctor Holmes in *The Professor at the Breakfast-Table*, tells of many large ones which gave him great pleasure in determining their dimensions. To the southward it is less common and of smaller size. It flourishes best on moist, rich bottom lands and along streams, but does well on low foothills and in well-drained "swales," or valleys. It is not as vigorous if planted on high, exposed, or dry places. It is a rapid grower in favorable situations. It has been recently attacked by a species of beetle which may prove a serious obstacle to its cultivation; it has already lessened its use as a shade tree. There are several quite distinct forms. Some assume a weeping habit; others form a compact crown; while still others show a plume-shaped crown.

The wood is heavy, hard, tough, difficult to split, coarse-grained, strong, with light, reddish brown heartwood and rather thick, lighter-colored sapwood. The annual rings are very distinct, as is also the difference between spring and summer wood. The medullary rays are small and inconspicuous. It is commonly credited with being durable when in contact with the soil or where it is alternately wet and dry. This is an error, for it decays quickly in such situations. Both Red and Cork Elm are more durable when exposed. It is used in the construction of agricultural implements, and in other places where toughness and

resistance to being split are required. It is also largely used for wheelbarrow bottoms and for cheap furniture, but the greatest demand for it is for light cooperage, for both staves and hoops. For a time it was looked upon as the only wood suitable for that purpose, but its rapid exhaustion has forced coopers to seek and use other woods; it still stands at the head of the list in adaptability for such use.

It cannot be depended upon to sprout from the stump, and consequently its propagation must come from seed, which is not at all difficult. The tree blossoms in early spring and before the leaves appear. It matures its seed late in May or early in June before the leaves are full grown, and the seed should be at once gathered and sown. The seeds are surrounded with a thin film or continuous wing, and, being light, are blown a long distance by the wind. The seed-bed should be a sandy soil, or one which will not crust over after a rain, the seeds sown in drills seven or eight inches apart, and, as not all seeds are fertile, from one half to one inch apart in the row. An abundance of moisture is requisite for good germination and growth of seedlings. They should attain a height of eight to twelve inches the first year, and can then be transplanted into the forest any time thereafter, although, if to be set out among bushes, it would be best to let them remain in the beds for another year, when they will frequently reach thirty inches in height. They are blessed with a large number of fibrous roots, and if reasonable care is taken in transplanting not three per cent should be lost. It is a comparatively shallow-rooted tree, and when mature throws its roots out to a great distance, as may be frequently seen along stream banks where they have been exposed. The sap pores in the roots are very large, frequent, and continuous. Water can be easily forced through them for several feet.

In order to grow valuable lumber, the tree must be crowded in early life to prevent its throwing out limbs low down, one or more of these frequently putting forth efforts

to become leaders. When grown in the open in early life it has little value for lumber. It is not known that it has been planted for forest purposes in this country, and a careful examination of young growth coming on from natural seedling must be our guide as to the distance apart the trees should stand in the forest, — probably from six to seven feet, according to fertility and moisture of the soil. The tree has so many valuable features that it will be safe to plant largely, especially in situations where it may not be profitable to cultivate land for farm crops, as along streams that frequently overflow their banks, and where it may be too wet to cultivate at all, or difficult to get at. While there are better species of trees for lumber, this can be grown where but few superior ones will thrive.

RED ELM: SLIPPERY ELM: *Ulmus pubescens*

THIS tree has substantially the same range as the White Elm. It can be grown in all respects in the same manner as that tree, and its wood can be used for the same purposes, with the additional advantage that it resists decay longer when exposed to the soil. It prefers the same kind of soil as the White Elm, but it seldom attains a height of over sixty feet or a diameter of more than two feet. It is quite similar in general appearance to the other Elms, but its leaves are larger and rougher. It grows more rapidly when young, but it is not long-lived, and its thick, live bark is heavily charged with mucilage which is frequently used in medicine.

The heartwood is brown-red and the sapwood thin and light-colored. The heartwood is strong, tough, coarse-grained, and, except being darker in color and resisting decay longer, is practically the same as that of the White Elm. The time of blossoming and ripening the seeds is substantially the same as that of the White Elm, but the seeds have a much wider film or continuous wing. Its cultivation should be along the same lines.

BASSWOOD: *Tilia*

WHILE botanists find six species of Basswood in the United States, only three of them have any economic value as timber trees. They are Basswood (*Tilia americana*), the largest and best of the three, White Basswood (*Tilia heterophylla*), and Downy Basswood (*Tilia pubescens*). The wood of these is nearly alike in commercial importance and the difference in the trees is mainly in the size, and as they grow in substantially the same sections of the country, it is not thought necessary to make any distinction in considering them. The term Basswood will include all three. In some markets, however, there is a distinction made in the lumber trade. White Basswood is classed separately, but the distinction is not general. In some localities all Basswood is called Linden. That is the name it bears in Europe.

The natural range is very great. With the exception of Florida, it may be found, more or less, in every state east of the Mississippi River, and also in the eastern portion of the states lying next to that river on the west. Its best development is along the bottom lands and in the rich soils bordering on the Ohio River and its tributaries, although fine specimens once grew on the upper tributaries of the Susquehanna River. Doubtless it was produced in greatest abundance and of the best quality in the valley of the Ohio. It seldom grew in pure stands, and when so found was limited to small areas. Its most acceptable neighbors are Ash, Hickory, Elm, Cherry, Yellow Poplar, Beech, and occasionally Oak and Black Walnut, all luxuriating in a rich, moist soil. It will grow indifferently well in a dry, poor soil, yet it would not be a profitable tree to plant in such soil, as it is not a rapid grower after thirty or thirty-five years of age. Nor should it be planted in situations exposed



BASSWOOD

Photographed by J. Horace McFarland.

to strong winds, as the wood is somewhat weak when green.

It can endure considerable shade, and to make it grow tall and free from limbs, it must be crowded in early life and until it reaches its height growth, when, if so situated, it will grow a tall, slightly tapering stem, free from limbs for forty or more feet. When it once overcomes its competitors, it will throw out a rounded and somewhat open top, with specialized limbs. Trees have been occasionally found from one hundred to one hundred and twenty feet high, with a diameter of four feet, but such growth is very unusual. A tree eighty feet high and thirty inches in diameter may be considered a large tree. Old trees are frequently hollow, and in many cases the heartwood is found entirely decayed for a portion of its height, and the tree still growing, showing that the only function the heartwood performs is to support the trunk and crown against the wind. The roots of the Basswood run deep, and have been known to penetrate fourteen feet and clog a sewer pipe.

The wood is soft, generally straight-grained, and of fine texture, not strong but tough, with light-brown heartwood and an extremely thick and nearly white sapwood. There is little difference between spring and summer growth, and the medullary rays are small and inconspicuous, plainly distinguishable in the live bark, however. Boards cut from Basswood can be steamed and bent into many shapes suitable for carriagework and like purposes. It takes glue, stain, and paint well, and is largely used for carriage panels and cabinetwork, exterior and inside finish, cheap furniture, toys, wood carving, pulp, and many other purposes where light soft wood is required. It is not durable when exposed to the ground or to the weather unless protected with paint. Logs cut from it should be sawed the same year that they are cut or injury will arise from decay. Lumber cut from some trees is frequently found to have hard black spots and streaks, from half an inch to two or more inches long and from a narrow streak to an inch or so wide, and

somewhat irregular in shape. They are not serious defects and their cause is unknown.

When the bark is peeled in early summer and thrown into water, the mucilaginous parting between the live annual layers soon decays, and the latter separate into long, ribbon-like strips constituting the common "bast" of commerce.

Basswood does not seed until about thirty years of age but after that will produce seed very frequently, sometimes every year for a long period. In the Middle States the blossoms appear in early July and the seed ripens by the first of October. The seed is encased in a hard, spherical shell, about one fourth of an inch in diameter. When this shell is removed, the seed proper will still be found encased in another hard coating. These shells prevent moisture from reaching the seed, and the result is that germination cannot take place until the outer shell decays. To facilitate such decay, the seeds should be planted as soon as ripe, and if not, they should be stratified in wet sand and placed where they can be alternately frozen and thawed during winter. They have been known to lie in the ground two years without any very perceptible change. There is as yet no known method of hastening the decay of the outer shell without destroying the vitality of the seed. Probably stratifying in sand and removing such as show evidence of growth in the spring is about all that can be done. The seeds can be sown in the seed-bed the same as Ash or Maple. The seedlings develop a stout root somewhat akin to a tap-root, but they can be deprived of it without much injury; yet it would be best to remove them into the transplant nursery in order to have a well-established root system when set in the forest. As the tree starts growth early in the spring, and will not stand removal after the leaves start, early planting is absolutely necessary. The tree sprouts from the stump quite freely, but sprouts seldom attain a size large enough for sawlogs without being decayed at the butt.

The United States Forest Service recommends planting Basswood trees five feet apart each way in the forest. This is rather close, as the tendency of the tree is to grow tall even in the open, and it is not given to throwing out large limbs until it has reached a considerable height; six feet apart would be close enough. Its rapid growth when young would insure a good forest floor in a few years. There are few diseases affecting it, and the value of the lumber — for we have nothing that can satisfactorily take its place — should warrant endeavors to overcome the difficulty of germination and cause the tree to be planted extensively. Its flowers are highly charged with nectar, and honey gathered from it has a delicious flavor. In some sections it is called the “Bee Tree,” partly because of its honey-laden flowers and partly because colonies of wild bees occupy the hollow spaces occasionally found in the upper part of the stem.

THE BIRCHES

OF the eight species of Birch in the United States, only three are of enough economic importance to warrant consideration. These are Black Birch (*Betula lenta*, frequently called Cherry Birch and Sweet Birch), Yellow Birch (*Betula lutea*, sometimes called Gray Birch), and Paper Birch (*Betula papyrifera*, in some localities called Canoe Birch). There is still another species which is occasionally converted into lumber, but its habitat is along low stream banks; hence the supply is quite limited. It is the Red or River Birch (*Betula nigra*), and can be depended upon to propagate itself if allowed to.

BLACK BIRCH: *Betula lenta*

IN general make-up this species is quite distinct from the other Birches, and it is not of so extended a range nor so common where it does grow. Neither does it shed its annual layers of dead bark as do the others, and its wood is harder and more valuable. Its range is from Maine westward to southern Indiana and Illinois and along the Alleghany Mountains to central Kentucky and Tennessee, and it is occasionally found in western Florida and northern Georgia. In the Northern States its companions in the forest are Beech, Sugar Maple, Black Cherry, White Ash, and Yellow Birch. It grows well on fairly dry ground, but prefers a deep, rich soil.

Its wood is strong, heavy, — green logs from thrifty trees will sink in water, — and is a very good substitute for Hickory for heavy wagon axles and similar purposes. It is excelled in hardness by few of our timber trees, and only Hickory is superior to it for fuel. From its close resemblance to Black Cherry, both in texture and color when

finished, the old heartwood is frequently substituted for it in furniture and interior finish, and the possessor of it is little wronged. The heartwood is of a reddish brown color, with light yellow sapwood frequently composed of fifty or sixty annual layers. It is close-grained, with very small and inconspicuous medullary rays. It takes glue well, and shows a satiny texture when properly finished.

It is of extremely slow growth, and seldom attains a large size before decay sets in. While furnishing valuable timber, its slow growth will prevent its profitable reproduction by planting. Natural regeneration occurs wherever an opportunity is given, as it is a prolific seeder and the seeds are scattered widely by the winds. Whatever the future of the tree may be, it must rest entirely upon natural reproduction. Aside from the general uses of the wood referred to, the twigs, small branches, and bark are distilled for the essential oil they contain, which is palmed off on an unsuspecting purchaser as "wintergreen," and he is not so greatly wronged as he might be, for it is preferred by some to the genuine article. When tapped or wounded in the spring, Black Birch yields an enormous amount of slightly saccharine sap, which will flow about the time the buds burst and the leaves begin to appear.

YELLOW BIRCH : GRAY BIRCH : *Betula lutea*

THIS is a very common tree in the Northern States, ranging from the Canadian line to North Carolina and Tennessee. Like several other species of trees, its wood was not deemed valuable until conditions forced its use. Until recent years lumbermen left it in the woods either to blow down, be burned, or scatter its light, winged seeds far and wide when its cones opened, which occurs early in the fall. A brisk wind will carry the seeds for miles. In some localities this feature makes it more than a weed tree, — it becomes a pest, as it grows rapidly in early life and suppresses more valuable species. In old age it grows slowly, and in some

sections of the country is liable to become hollow when large enough for the saw. Trees sometimes attain a height of ninety or one hundred feet and a diameter of four feet, but such dimensions are rare.

The wood is close-grained, heavy, strong, compact, hard, but not durable when exposed to the weather or the ground. The heartwood is light brown tinged with red, with sapwood thin and nearly white. There is little difference between spring and summer wood, and the medullary rays are small and inconspicuous. It takes glue and stain readily, — all Birches do that, — and so close an imitation of dark mahogany is attained with it that only the very expert are undeceived; yet a slight bruise will disclose the counterfeit. It is used mainly for furniture and interior finish, veneers for panels and seats, boxes, and for many purposes where a rather hard and strong wood is required. It is fairly good fuel and will serve a good purpose in the farmer's woodlot.

Its companions in the forest are Black Cherry, White Ash, Maple, Basswood, Black Birch, Beech, and it may occasionally be found growing with Hemlock. In northern New England, Yellow Birch grows abundantly with Red Spruce. All the above-named hardwoods are far better for timber than it is, and as they will grow in the same localities, and in the same soil, they would best be grown in its stead. Add to this the fact that it will reproduce itself naturally and it will be seen that any effort to grow it artificially, except, it may be, in the woodlot, would be useless. Like the Black Birch, it will give an abundant flow of slightly saccharine sap if wounded in late spring.

PAPER BIRCH: *Betula papyrifera*

IN many respects this tree resembles the Yellow Birch. Both shed annual layers of dead bark when young, the Paper Birch characteristically so. In old age the annual layers of bark cease to separate and the bark becomes thick and firm. This feature is taken advantage of by Indians

and others who make the well-known bark canoes of it. This gives it the name of Canoe Birch. The thin, creamy-white layers of bark, which separate when the tree is comparatively young, may be used as a substitute for paper, hence its botanical designation, *papyrifera*. Like the Yellow Birch, the tree is a prolific seeder, and its seeds are blown to a great distance, and natural reforestation readily occurs.

Its natural range is in the northern portions of our country, and where seen in the Middle States it seldom attains a size suitable for a sawlog, generally reaching the pole stage only and even falling below that. Its best development is in the states bordering on the Canadian line.

The wood is light, very close-grained, strong, tough, and hard when seasoned. The heartwood is light brown, tinged with red, and the sapwood is thick and nearly white. It is largely converted into spools, and for that use is shipped to Europe. It is also made into "excelsior," and is likewise used for pulp, turnery, veneers, and fuel. Like the other Birches, its natural reproduction can be depended upon. In fact, it will, if allowed to, crowd out all other species on a cut-over or burned tract. Its propagation for lumber should not be undertaken. It is useful, however, in covering the surface of burned districts and preventing erosion of the soil.

BEECH: *Fagus americana*

THIS well-known tree is distributed, intermittently, throughout nearly the whole country east of the Mississippi River. It is one of the very few trees that have escaped a number of names. It is universally known as Beech, although in some sections it is called Red, White, and Ridge Beech. It was long used for a limited number of purposes, but as other species of timber trees became scarce, it has been made to play its part in furnishing a supply of lumber, and it is now put to many uses, mainly because nothing better can be secured for the money. Homer says the Beech is "the tree of Father Jupiter." When grown in a dense stand, it sends up a straight, smooth, and slightly tapering stem, clear of limbs for fully one half or more of its height, with comparatively small and short crooked limbs; but when in the open, it branches out low down and forms a rather dense and rounded crown. It is tolerant of shade, as much so as any of our timber trees. It has been known to reach a height of one hundred and fifteen feet, with a diameter of forty inches, but the average of what may be called mature trees is much less, ordinarily reaching a height of seventy-five feet and a diameter of eighteen to twenty inches.

There is quite a prevalent belief that there are two species in this country, Red and White Beech. That is a mistake. When in the open, the tree grows rapidly in early life. It is not unusual for it to make an annual growth of one fourth or even five sixteenths of an inch during the first thirty or forty years of its life, and nearly all of this will be sapwood and white; but in the forest its growth is slower, and for some unknown reason the change from sapwood is there more rapid and the relative amount of sapwood is much less; this has given rise to the belief in two



BEECH

Photographed by J. Horace McFarland.

species. Like that of all other trees the sapwood will decay sooner than the heartwood, and because Beech trees were found lying on the ground in the deep woods, with the sapwood all rotted away and the red heartwood sound, it was assumed that "Red Beech" was a distinct species.

The wood is strong, tough, hard, but not durable. It is close-grained, with little distinction between spring and summer growth. It is difficult to season. The heartwood is quite red and the sapwood nearly white. The sapwood is mainly chosen for plane stocks, saw handles, and other uses where wood is required capable of taking on a fine finish or withstanding wear. It is used for turned and other parts of cheap furniture, and is now being converted into flooring. It has long been known as "clothes-pin wood," and for a time that was about the most extensive use it was put to.

It is not an early or a frequent seed-bearer, but generally produces a generous crop when it does fruit. It may be readily grown by planting the little triangular nuts, but as it is a difficult tree to transplant, the seeds would best be sown where the trees are to grow. It has many lateral roots, which, when growing in the forest, run close to the surface of the ground. These are filled with adventitious buds, which spring into growth as the tree advances in age, and a dense undergrowth naturally results, and there is little difficulty in producing a natural stand, but, as a rule, these do not produce large trees. Still, they will serve an excellent purpose for fuel, and a young, vigorous Beech, properly seasoned, has few superiors for such use, either in a closed stove or on the open hearth. Yet this tendency to grow from sprouts should not govern in the decision whether it is to be grown to the exclusion of better trees, such as White Ash, Black Cherry, Sugar Maple, Basswood, and some others, which naturally grow with it in our forests. These superior trees can be more readily propagated, and hence artificial reproduction of the Beech can hardly be justified, except in the case of the farmer's woodlot, where it could be made to play an important part in the

production of excellent fuel. In such cases it need not be planted as closely as when grown for saw timber, for the trees will produce a greater weight of wood when grown ten or twelve feet apart than if planted closely enough to compel them to drop their lower limbs when young. Its little nuts are rich and delicious and are highly prized by men and nut-eating animals of all kinds. They should be gathered as soon as ripe and not allowed to become at all dry, for their vitality will be destroyed if they do. They should be planted at once or stratified in moist sand until spring and placed in the ground as soon as conditions will permit. Beech is a favorite timber tree in Europe, but it is there quite distinct in growth and character — in fact, a different species.

In some localities it is seriously affected with what is known as “white rot.” A fungus attacks it, and while the outside may be alive nearly the whole interior is decayed. The United States Forest Service states that ninety-five per cent of the Beech in the Adirondack forests of New York is affected. The disease is known to exist quite seriously elsewhere.

BLACK WALNUT: *Juglans nigra*

IN the early settlement of our country, trees were cut down mainly for the purpose of clearing the land for agriculture, and few or none suffered more from such work than Black Walnut. This came about because it occupied the best and most fertile lands in the valleys and the low foothills bordering the principal streams, and hence was the first to be attacked. Large numbers of trees were cut down and burned. As it is very durable when exposed, and splits easily, it furnished the fence rails for many a farm. Later it was discovered that the wood was very valuable, and then, without any consideration for a future supply, its destruction went on rapidly, and it is now nearing exhaustion. At present lumber cut from that tree brings in the market the highest price of any of our native woods. Nor is its value limited to lumber cut from the body of the tree, in the sawmill, as is the case with nearly all other species of timber trees, but limbs, crotches, and stumps are sought to be worked into veneers, gunstocks, and for many other purposes where fancy woods are desired. Stumps of trees cut years ago are being dug up and bring large sums. Old fence rails have been gathered for turnery, and old furniture secured and cut into veneers and for other purposes for which it was fitted.

The natural range of the Black Walnut is from Massachusetts west to eastern Nebraska, south from there to eastern Texas, near the Gulf; thence easterly to Florida, and from there through western Georgia and the Carolinas to Norfolk, Virginia, and on northward to Massachusetts. It also grows in Canada along the St. Lawrence River. Its best development, both in size and quality, was west of the Alleghany Mountains and on the fertile slopes of the Appa-

lachians in North Carolina and Tennessee. It revels in rich bottom lands and on fertile hillsides, where it grows most rapidly and yields the best lumber. Thus far efforts to grow it outside of its natural home have not proved very successful; yet such attempts may have been made in unsuitable soils, or, what is more probable, by transplanting trees instead of planting seeds where the trees are to grow. This last would account for practically all failures, even if the soil and location were what the tree demands — in both of which it is very exacting, few trees more so. If soil and location favor and the seed be planted where the tree is to remain, it will be found a rapid grower and good results will follow. It will grow in a not very fertile soil and in comparatively dry ground, but the growth will be slow and the quality of the wood inferior.

It is decidedly a light-demanding tree. If grown in the open, it throws out limbs low down, which become large, crooked, and forked, though not particularly specialized, each one striving to become the largest. If crowded in early life, it will send up a tall, straight, slightly tapering stem one hundred to one hundred and thirty feet in height, clear of branches for more than one half its height, with a diameter of even six feet; but such trees are seldom found.

The heartwood is a rich dark brown, with a rather thin and nearly white sapwood. It is hard, strong, durable; is generally straight-grained and splits easily; of a very fine, satiny texture; takes glue well, and is susceptible of a very fine finish. The wood is easily worked, and there is little difference between spring and summer wood either in hardness or color. It is rather coarse-grained, with quite conspicuous pores mingled with the spring and summer wood, but the medullary rays are not prominent or very numerous. The crotches and roots are beautifully waved and mottled and are almost invariably cut into veneers or made into gunstocks. Such parts of the tree as are not used for these purposes are now mainly devoted to fine furniture, interior finish of expensive apartments and boats, while

large quantities are cut into veneers. Much of that now harvested is shipped to Europe in the log.

The tree blossoms late in May and ripens its fruit in October. The nuts should be gathered as soon as ripe, for squirrels — to which should be mainly credited their distribution in the forests of the past — are extremely fond of them. They should be at once planted or covered in layers of sand, where they can be frozen during winter, and planted as early in the spring as possible. In no case should they be permitted to become dry. The tree develops a very prominent tap-root the first year of its life, frequently going down into the ground twenty or more inches, while the stem may not have raised its head much over eight inches above the surface. It resents interference with this feature of its development and seldom fully recovers from its injury or removal, notwithstanding the fact that it will naturally throw out prominent lateral roots as it grows older. From this it will be seen that growing plants in the nursery and transplanting them into the forest, or anywhere, cannot be expected to result in complete success. The only certain way is to plant nuts where the trees are to stand until mature. Fall planting will be best if there is no danger that squirrels or other nut-eating animals will destroy them. They should be covered from one to two inches deep, according to the character of the soil. The seedlings grow from six to eight inches high the first year, and will make good headway in their struggle with unwelcome neighbors. They should not be planted in the shade.

While the nuts are valuable and are highly prized, no returns from these should be expected from trees grown in the forest, for they will not bear until old, and then sparingly. Those grown in the open will produce fruit, but at what age is not definitely known, possibly at twenty-five or thirty years. To bring forth tall, straight trees, free of limbs for twenty or thirty feet, planting must be close and thinning carefully done. Probably six by six feet apart would be about right for rich ground, but five by five feet

would serve best in less fertile soil, while the leader should be carefully watched, and if it divides, one of the parts should be promptly removed. But there is less need to grow this tree slim and straight than with most others, owing to the value of crotches and crooks. Hence trees grown in the fields, along streets, in by-places, wherever the ground is suitable, may be as profitable for timber as in dense stands, and more so for fruit.

The great value of the wood and nuts should lead to its cultivation wherever land is suitable and not too valuable. There are small areas on many farms located within its natural range which cannot, for one cause or another, be devoted to tillage, but are suitable for growing this tree, and the advisability of planting such is obvious. Unfortunately it has a caterpillar enemy which sometimes strips it of its leaves.

BUTTERNUT: *Juglans cinerea*

WHEN grown in the open, the general appearance of the Butternut somewhat resembles the Black Walnut, and is frequently mistaken for that tree by persons not familiar with both. The similarity is more in its leaves, however, than in any other feature. It seldom forms a straight stem and can rarely be seen without crooks, crotches, and bends, even where crowded in the forest. It is emphatically light-demanding, and to secure logs at all satisfactory for the saw it must be grown in a close stand.

It may be found more or less along streams and in rich, moist soil from Maine to northern Georgia, and westward to the Mississippi River. In some sections it grows on the lower slopes of hills and mountains with Maple, Beech, Birch, Cherry, Oak, and White Ash. Trees one hundred feet high and three feet in diameter have been known, but they are very rare. It seldom exceeds half these dimensions. It is a rapid grower when young, but is much given to decay when old, and cannot be considered a long-lived tree.

The wood is very light, soft, straight-grained, of a beautiful satiny texture, and susceptible of a high finish — by some esteemed equal to Black Walnut. When stained, it closely resembles that wood, but such treatment is little short of sacrilege, for it is beautiful in its own garb. Its medullary rays are inconspicuous. There is little difference between spring and summer wood, and it has a fine grain. The heartwood is of a yellowish color, growing darker on exposure, with a thin, nearly white sapwood, composed of not more than six or seven annual rings. It seasons well and is easily worked. It is used for furniture and other like purposes, and also for pulp.

The tree is not an early seed-bearer, seldom bearing

fruit before thirty-five years of age. Neither is it very prolific when it does fruit. It has a tap-root and hence is difficult to transplant, and such trees as survive the operation are short-lived. Propagation should be the same as for Black Walnut in all respects, as it is closely allied to that tree. It bears a delicious nut, and trees planted where cultivation of the soil is difficult or unprofitable will amply pay for the care and use of the ground, as many prefer the nut to the Walnut. The tree is sometimes called "White Walnut," which is an appropriate name, for it is a Walnut. However beautiful its wood or however rich its fruit, it can hardly be classed as a profitable timber tree owing to the peculiarities noted.

LOCUST: *Robinia pseudacacia*

IN varying localities this tree is respectively called Yellow, Black, Green, and Red Locust, — with several other prefixes, — but the lumber trade and general public know it as “Locust.” It presents an interesting illustration of the possibility of spreading a tree far beyond its natural range. Its original home was in the Alleghany Mountains, reaching from northern Pennsylvania to northern Georgia, with its best development on the western slopes of the mountains of West Virginia. It has been spread by cultivation through most of the states lying north of Georgia from the Atlantic Coast westward to beyond the Mississippi River, and has recently been introduced into California. This wide extension has been brought about, in part because of its usefulness through the durability of its wood when exposed to the soil, — only Red Cedar and Hardy Catalpa rivaling it in that, — in part for its rapid growth when young, but largely for ornamental purposes, consequent upon its profusion of white, fragrant blossoms.

Because it will thrive in certain localities peculiarly suited to it, it has been too frequently deemed adapted to all in that vicinity, which, in many cases, is not the fact. In its native home it may be found growing vigorously on moist, fertile soil, especially on rich bottom lands along mountain streams and at the foot of hills, while on high mountain slopes and ridges but a few miles away it may be of much less economic value; although in such situations it may, now and then, grow tall and slim, but barely large enough for fence posts, and in many cases it may die before reaching that size, or grow branched and crooked. It is a very capricious and much overrated tree, and before planting it extensively for any purpose, except small poles and posts, great

care should be taken to secure a suitable location, as it is less reliable outside its natural habitat than within it. Besides its exacting demands for acceptable soil and location, it suffers greatly from a species of borer, which attacks not only the stem of the tree, but its branches and even small limbs, and against this assault there is no defense. Professor C. S. Sargent, in his *Silva*, says: "The value of *Robinia pseudacacia* is practically destroyed in nearly all parts of the United States, beyond the mountain forests which are its home, by the borers which riddle the trunk and branches." The author's recent observations in West Virginia disclosed the fact that the borer had invaded that region and was doing much damage. To this must be added that in many localities, including some portions of its natural range, a dark brown beetle commonly called the "locust leaf miner," has recently attacked its leaves. But as there are locations where it does thrive, and where neither beetle nor borer has yet worked serious damage, it is deemed justifiable to treat of its character and the best methods of propagation.

In its best development trees were found from eighty to ninety feet in height and from three to three and one half feet in diameter, but such dimensions were rare. Its average size does not exceed seventy-five feet in height or more than twenty inches in diameter. It is light-demanding, but notwithstanding that fact it will grow quite tall in the open, while in some localities its habit is to separate and throw out branches low down, each one of which soon sets up a struggle for supremacy as a leader, and unless suppressed or removed, the contest will cause the tree to change its form and shoot upward with two, three, or more stems of nearly equal size. This tendency operates strongly against its usefulness, for if all the ambitious stems are allowed to grow, it will require a much longer time for any one of the several branches to reach a useful size than would be necessary if all the wood could be grown in one. Close planting will somewhat prevent this, but cutting back all but

the straightest and most vigorous stem is the only way to control it, for close planting has its drawbacks. When close-planted or shaded by dominant trees, it at once begins to fail in vigor and show decay.

It grows rapidly when young, and when in favorable situations will make a yearly growth of three feet in height, with an increase in diameter of one half to three fourths of an inch. But even in the most acceptable locations this rate cannot be depended upon for more than twenty or twenty-five years at farthest. It generally begins to fall off in rapidity of growth when fifteen or twenty years old, and from that time on its annual rings gradually lessen in thickness. As a rule, it cannot be relied upon to produce a standard railroad tie under forty-five, and frequently not under fifty, years of age. It is well adapted to growing fence posts and will do that in twenty to thirty years.

The wood is heavy, strong, hard, coarse-grained, stiff, and extremely durable when in places where it is exposed to the soil or where alternately wet and dry. The heartwood is generally a yellowish brown, but occasionally will have a pale green tinge. The sapwood is yellowish white and extremely thin, frequently consisting of but four or five annual layers. The wood is principally used for fence posts, and, where large enough, for railroad ties, in ship-building, and also for mudsills and in places where great durability is desired. Owing to the scarcity of trees large enough for sawed lumber, — brought about mainly by the fact that the most valuable stage of its life is when it will make fence posts and ties, — there is but little manufactured locust lumber offered in the market.

It is one of the few valuable species of our forest trees that will grow from sprouts without rapid deterioration of its vitality. It throws up sprouts from adventitious buds on its small surface roots, and hence these sprouts do not suffer from decay of their roots, as they would if growing from decaying stumps; but if permitted, they will spring up so as to produce dense thickets and be worthless. With

the exception of the California Redwood, the Beech, and the Chestnut, the Locust is the only valuable species that can be reasonably depended upon to reproduce itself by sprouts. Other trees, like Basswood, Hickory, Yellow Poplar, Cucumber, the Oaks, and a few others, occasionally sprout if the tree is cut when young, but it is very seldom they do to any satisfactory extent.

The Locust blooms in late May or early June, according to locality. The seeds are in pods — it is a legume — and are ripe by October, and can be gathered and sown at once or kept cool and planted early in the spring, the earlier the better, for even then they may not germinate under two years. The pods will hang on the trees until late winter. The seeds are encased in a hard shell, and if planting is delayed until spring they should be placed in water nearly boiling hot. Such seeds as swell during the operation of scalding should be removed, and more hot water put on such seeds as have not expanded, until all have swollen, when they should be promptly planted, for their vitality will be destroyed if they then become at all dry. They should be sown in the seed-bed in rows eight inches apart and two inches apart in the row, if only swollen seeds are sown. The seedlings can ordinarily be transplanted into the forest when one year old, for they may then have attained a height of eighteen inches.

Some of the railroads have planted Locust for ties, spacing them six, eight, ten, and twelve feet apart, but just the right distance has not been determined, as it depends largely upon the character of the soil and location. It is to be regretted that some of the plantations set out by the railroads are not as promising as anticipated, and other trees are being planted in their stead. This comes, no doubt, from causes which arise from the tree's idiosyncrasies. Notwithstanding the many discouraging things which must be related of this tree, it has some remarkably good qualities and should be cultivated wherever it will thrive, but only careful observation can determine that.

HONEY LOCUST: *Gleditsia triacanthos*

HERE is a tree which so much resembles the common Locust in its leaves, fruit, and wood that there should be no wonder that it is called a Locust, yet, botanically speaking, it is not a Locust. The prefix "honey" to the common name has, no doubt, been given because of the sweetness of its seed-pods. However incorrect its common name may be, it has come to stay, although it has several others by which it is known. The tree may be readily recognized by the prominent thorns or spines which almost invariably appear on the stem and limbs. These are, probably, abortive developments of adventitious buds, sometimes single, but more generally three-forked, hence the botanical designation *triacanthos*.

As indicated, its wood closely resembles that of the common Locust, and all efforts to ascertain whether there is any distinction made in the lumber trade have failed. There should be no discrimination made against the Honey Locust, for its wood is quite equal in value to the common Locust for all purposes, and in fact superior to it for some.

Like the common Locust, its natural range was somewhat restricted, but it has been spread, mainly for ornamental purposes, over a much larger area than it originally occupied. Its original home extended from central New York south to Georgia and from the Alleghany Mountains to eastern Kansas and Nebraska, but it may be found as an ornamental tree, or grown for hedges, in almost every state east of central Kansas. While it is very abundant in central Kentucky, its best development is along the rich, moist river bottoms of southern Indiana and Illinois. It thrives best in such situations, yet does fairly well in any moderately fertile soil, if not too wet. It is by no means as exacting or capricious in regard to soil or location as the common Locust,

and it is equally hardy. If the soil is deep, it will grow on dry ground, and the indications are that it will do well in the Middle West where the rainfall is somewhat restricted. It is light-demanding, and if not crowded will generally branch out low down, and instead of throwing up a single stem there will be several of them struggling for supremacy. In this it exhibits the same objectionable feature as the common Locust. Advantage has been taken of this tendency in planting it for hedges and fences. If cut back to near the ground when young, it will throw up numerous branches, and if properly handled will form an almost impenetrable barrier, which is made more formidable by its thorns. It does not sprout from the roots unless they are wounded.

Its propensity to branch can be easily controlled. Close planting in the forest will cause the lower limbs to die and drop off, and the tree will then throw up a straight stem clean of large limbs. It is a rapid grower, and an annual increase in height of two feet and one half inch in diameter is not uncommon in favorable locations, for a score or more years, and in less favorable ones it will generally add a foot or more in height and increase in diameter fully one third of an inch.

The wood is very hard, strong, heavy, coarse-grained, and with a marked difference in appearance between spring and summer wood. The heartwood is a bright red brown, frequently nearly red in thrifty trees, with thin and pale sapwood, the latter seldom over fifteen annual rings and frequently not over ten. The medullary rays are numerous, but small, and are conspicuous for their brilliancy, and if the lumber is sawed radially they add much to its beauty when finished. It is very durable when exposed to the soil, and for all uses where great durability and strength are required, it has few superiors. It is mainly used at present for fence posts, rails, hubs of wheels, and general construction, but must, eventually, be grown for saw timber and its use extended.

It is a good seeder and bears quite abundantly after

twenty-five years of age, sometimes earlier. The seeds are in pods, — it is a legume, — and they should be gathered in the fall and placed where they can dry out, when the pods can be readily broken and the seeds will fall out. The seeds may be sown in the fall or stratified in moist sand. Freezing will not injure them, but they should not be allowed to become very dry. If kept until spring, they should be placed in hot water and kept warm until the seeds swell, and as soon as that occurs they must be planted, for any drying or delay then will prove fatal. It may be necessary to renew the hot water several times, removing all that have swollen before this is done. They can be planted in the seed-bed in rows six inches apart and two inches apart in the row, and from one half to three fourths of an inch deep. The soil should be kept moist until the plants are well established. If all things are favorable, the seedlings may reach a height of ten or twelve inches the first year. They can be removed from the seed-bed when one or two years old, depending upon the condition of the ground into which they are to be placed. Transplanting in the nursery is not necessary, although it would strengthen the plants and aid them in overcoming adverse conditions when placed in the forest. There should be slight loss in transplanting, if done with reasonable care. Commercial nurserymen find no difficulty in growing this tree from seed. It is not attacked by borers, and so far as known has no fungus disease, nor is it attacked by any insect.

It is not known just what distance the trees should be placed apart in the forest. This must be governed by the character of the soil—the poorer the soil the closer they should be set. It must be remembered that they are eminently light-demanding and should be placed close enough to overcome the tendency to throw out limbs. Probably from four to six feet apart, according to the character of the soil, would be about right. If set too thick, thinning will remedy it, but no treatment can overcome the mistake of planting too far apart.

CUCUMBER : *Magnolia acuminata*

NOTWITHSTANDING that this tree has several names, it is best known by the one here given — this, no doubt, because the shape and color of its fruit, when green, somewhat resemble a cucumber. There are seven species of *Magnolias* growing naturally in the United States, but this is the only one producing timber of any commercial value. Its natural range is not very extended. It is largely confined to the Appalachian Mountains, and their eastern and western slopes, from central New York to central Georgia and Alabama, spreading out, however, to southern Illinois, and into Kentucky and Tennessee. It has never been found abundant in any one locality, and frequently is entirely absent from sections surrounded by regions where it is to be found. This is, no doubt, because the percentage of fertility of its seeds is very low and both fruit and seeds are extremely bitter and obnoxious to the taste of man and brutes; and, as the seeds have no wings to enable them to be carried by the wind, they are not widely scattered.

Its best development is at the base of the mountains of eastern Tennessee and Kentucky and in West Virginia. It prefers a rich and rather moist soil, but thrives well in the not very fertile soils of the carboniferous formation in West Virginia and Pennsylvania. When grown in the open, its crown forms a fine pyramid, with limbs from near the ground up to a sharp apex; but being light-demanding it will, when crowded, produce a straight, slightly tapering, smooth stem, sometimes fifty or more feet without a limb, and with a diameter of three and one half to four feet, and a total height of one hundred feet.

The wood is light, soft, brittle, straight- and fine-grained, easily worked, and does not warp or split when seasoning. The heartwood varies in color from a light yellow-brown to a dark reddish brown, with frequent streaks quite like pale



CUCUMBER, NEARLY FIVE FEET IN DIAMETER, IN VIRGIN FOREST
Man standing near it; other trees are mainly Hemlock. John E. DuBois Estate,
Elk County, Pennsylvania.

Photographed by Dr. Hugh P. Baker.

burnt umber. Occasionally it may have a tinge of olive green. The sapwood is thin and of a yellowish white. There is little distinction between spring and summer wood. It is used for furniture, especially for bottoms and sides of drawers, interior finish, pump stocks, and for most purposes for which White Pine can be used, except where strength is required; and it is more durable when exposed. It takes glue, paint, and stain well, but shows a rather dull finish under varnish. It is rated in the market as about equal to Yellow Poplar in quality and value, except for pump stocks, for which it is preferred.

It is not a frequent seeder, nor is it a prolific one. When ripe, the fruit is a brilliant red, and generally crooked and distorted in shape. The seeds are a bright scarlet, and suspended from the fruit by a white thread an inch or more long. They should be gathered as soon as ripe and stratified in moist sand and kept in a cool place. Freezing will not harm them. Seeds should be sown in the nursery the same as those of Ash or Maple. The plants grow quite rapidly after the first year and may be transplanted into the forest when two years old, although it would be best to place them in the transplant nursery for another year. The roots are brittle and few fibrous ones are developed, which makes transplanting into the forest difficult and uncertain. The tree grows rapidly when young, and it maintains its vigor quite well for a long time. The value of the wood will justify an earnest effort to propagate it. Scarcity of seed and its low percentage of fertility are serious hindrances to its propagation. If injury occurs to a tree in its early life, sprouts will be thrown up from the stump, but these seldom attain a size large enough for the saw, and when they do they are generally decayed at the butt. The same treatment should be accorded it in the nursery and in transplanting it into the forest as is given to Yellow Poplar, White Ash, and Maple. Probably the plants would best be planted about six feet apart, but in rich soil seven feet would be advisable. It cannot be ascertained that any experience has been had in planting it in the forest.

SYCAMORE: BUTTONWOOD: BUTTONBALL:

Platanus occidentalis

THIS tree is burdened with nine names. The Indian name, when translated into English, was "Big Stockings." Those most commonly applied to it are "Buttonwood" and "Buttonball," and these were, no doubt, chosen from the ball form of its fruit. *Platanus* is the classical name for the Oriental Plane Tree, now known to botanists as *P. orientalis*, which is largely planted for ornament in Europe, and has lately been introduced into this country.

No one who has taken a good look at this tree will fail to recognize it afterwards, although few trees so change their general outline and form of crown when passing from youth to old age. From early to nearly middle life, it sends up a straight stem with straight limbs slanting upward and forming, when in the open, a formal and regular pyramid from near the ground to a pointed apex at the top. When it is approaching its height growth, whether growing in the open or in a crowd, limbs that were once straight and regular begin to droop and straggle and assume irregular shapes, with bends and crooks, and the crown is wholly unlike that in early life. When grown crowded, it shoots up a tall, straight stem free from limbs for two thirds of its height. Groves of young trees may be frequently seen, where the stand is crowded, that have the appearance of a mass of painted poles with a few stag-horn branches at the top. Being very intolerant of shade, it seeks to obtain light and outstrip its competitors.

It has another peculiarity, wherein it differs from most trees. Like all others it annually forms a layer of live bark next to the cambium, and as regularly an annual layer dies on the outside of the live bark; but instead of being elastic, or accommodating itself to the increasing size of the tree,

the dying layer — except at and near the base of mature trees — annually scales off, leaving the live bark without such protection as is afforded by the dead bark of most trees. This dying layer is at first white, but as the season advances it generally turns to an olive-gray, and when it falls off in patches, as it usually does in winter-time, it causes the tree to look as though liberally splashed with whitewash. As the tree approaches maturity, the dead bark adheres to the stem from the ground upwards for some distance and forms scales somewhat resembling those of the White Ash. The adhering dead bark is of a gray color, making the tree show a darkened base surmounted by a mottled or whitewashed stem and branches.

There is still another peculiarity in which it is almost entirely alone. While buds are regularly formed, in late summer, for a succeeding year's growth, none are visible until the leaf stem separates from the branch. The base of the leaf stem — the petiole — entirely covers the bud formed for the next season with a cover much resembling the old-fashioned conical candle extinguisher.

It has an extended range, reaching from Maine and southern Michigan to northern Florida and the Gulf of Mexico, and from the Atlantic Ocean to eastern Texas, Oklahoma, Kansas, and Nebraska. (There is a species in California, but it is of little economic value for timber.) It flourishes best along streams and in moist fertile soil, where it grows quite rapidly in early life and keeps up a fairly thrifty condition for a long time, reaching an old age. It will grow in somewhat dry soil, but seldom attains its largest size there. Its best development is along the Ohio and Mississippi rivers and their tributaries, especially the Wabash and Miami, where it has been found one hundred and fifty to one hundred and seventy-five feet high, with a diameter of ten to eleven feet, with a tall, straight, and clean stem, lessening but little in diameter as it nears the crown. Many large trees once existed along the Susquehanna and Delaware rivers. Old trees are liable to be hollow. Pro-

fessor C. S. Sargent¹ declares it to be "the most massive if not the tallest deciduous-leaved tree of North America."

The heartwood is yellowish brown, with thin and light-colored sapwood. It is of medium weight, close-grained, rather tough, very difficult to split, and with very numerous, small, but decidedly distinct and conspicuous medullary rays. None of our timber trees surpass it in this respect, and when quarter-sawed it is susceptible of a very beautiful finish, and hence it is, latterly, being used for cabinet and interior work. Until within the last score of years it was used almost exclusively for butcher's blocks and plug-tobacco boxes. It is difficult to season because of its tendency to warp, and it decays quickly when exposed.

It is an early and prolific seed-bearer. Its well-known ball-shaped fruit hangs on nearly all winter, disintegrating in the spring, the winds scattering the seeds far and wide. Falling in the running streams, they lodge along the borders, in the sand and gravel banks and exposed bars, and large numbers of plants spring up, but they are mostly destroyed by the freshets of the succeeding spring. These young seedlings frequently attain a height of eight to twelve inches by fall, and may be secured and planted at once or heeled-in until spring. Spring gathering would be better, but there is danger of their destruction by freshets if left until then. The young plants are well supplied with fibrous roots and their removal and subsequent treatment are not at all difficult, if set in proper ground. The tree can be grown from cuttings. These should be gathered in the fall and cut about twelve inches long from the current year's growth. They should be heeled-in in a moist place and protected from frost. In such a situation they will callus by spring and growth will generally occur. The callused cuttings should be planted where the trees are to grow, as plants from cuttings do not generally bear transplanting.

If the plants cannot be obtained, the seed can be gathered in the fall or winter, separated by crushing the ball,

¹ *Manual of the Trees of North America*, page 345.

and sown in early spring in moist, rich ground and treated as are other broadleaf species. They grow quite rapidly in early life, and need not remain in the nursery beds more than two years. As the tree naturally grows in ground unfit for cultivation, because of overflow, its propagation should be encouraged there. If this is undertaken, the tree should not be allowed to throw up several stems from the same root, a thing which it is liable to do.

In recent years it has been attacked by what appears to be a fungus disease. Soon after the leaves appear in the spring they begin to shrivel and curl, turn brown, and die. New ones generally put out, but the tree is checked in growth and frequently does not readily recover, and seldom if attacked the next year. It is denied that this is a fungus disease or an attack of insects, but it is alleged to be the result of climatic or meteorological conditions. This may be so, for all the trees may be attacked in a section of the country one year and not the next.

THE COTTONWOODS: POPLARS

TECHNICALLY speaking we have no Cottonwoods, but there are nine species of trees indigenous to the United States that are generally known as Cottonwoods; yet botanically they, together with two others, are Poplars, and to persist in calling these nine species Poplars would lead to confusion in the minds of those not familiar with botanical nomenclature. The two species of Poplars not classed as Cottonwoods are commonly called Aspens. They are Trembling Aspen (*Populus tremuloides*) and Largetooth Aspen (*Populus grandidentata*). It is seldom that either of these grows large enough in the United States to be of value for saw timber, and at best they are worth but little for that, yet they are considered the most valuable of any of our woods for paper pulp. It is only in the extreme northern portion of our country that they attain a size to make artificial cultivation a profitable undertaking. They reproduce themselves abundantly whenever offered an opportunity, even to the extent of becoming a nuisance by crowding out more valuable species; hence they will not be further considered here.

There is one feature common to all the Poplars and Cottonwoods. The stem of the leaf — botanically, the petiole — is flat and its face is at right angles with the face of the leaf, and this permits a slight wind to cause the leaf to vibrate, hence “Trembling Aspen.” Three species of Cottonwoods are, to some extent, manufactured into lumber, but as there is little difference in them a consideration of one will substantially cover all, notation being made where they differ. These are known as Swamp Cottonwood (*Populus heterophylla*), Balm of Gilead (*Populus balsamifera*), and Cottonwood (*Populus deltoides*). The last species is best known and most important. For a long time it was known

as Cottonwood, but latterly it has been called Carolina Poplar, a name given to it, no doubt, by some enterprising nurseryman to disarm a prejudice generally felt towards the Cottonwoods, and it has been palmed off on an unsuspecting public as a newly discovered species of Poplar, and one well adapted to ornamental purposes — for which it has only one redeeming feature, that of rapid growth. It should have no place on the lawn or street. In some sections it is known as Necklace Poplar, and there is no more reason for calling it Carolina Poplar than there is for designating it Virginia Poplar, or affixing the name of any other state, for some variety of it grows in nearly every state east of the Continental Divide. Strictly speaking, it should not be placed in the class of important timber trees, for, except as will be noted, it is of little value for lumber alone ; yet there are some uses to which it can be profitably put, whereby it may play an important part in forest economy. It is a first-class wood for paper pulp, and by its rapid growth it may be made to bring quicker returns than any other native forest tree. It can also be made useful in protecting stream banks from erosion, as it will thrive on ground too wet for trees that will produce more valuable lumber and which is too wet to cultivate. It is readily reproduced by sprouts from cut stumps and roots, and can also be propagated by cuttings set in the ground where the trees are to stand. These features certainly warrant placing it in the list of trees worthy of cultivation.

It must not be said, however, that it is invariably of little value for lumber, for along the valleys of the Mississippi and Missouri rivers the character of the wood is quite different from that grown elsewhere, and it is there known as Yellow Cottonwood. Lumber cut from trees grown there is reported easy to work, can be dressed smooth, serves a fair purpose for work that is not exposed, will take on a good finish, and is adapted to many purposes for which Yellow Poplar is used. As there appears to be no marked botanical difference in the trees there and elsewhere, the

difference in character of the wood is, no doubt, caused by difference in soil, moisture, or climatic condition, or all of these — features which affect all species of trees.

Its best development is in the valleys of the Mississippi and Missouri rivers and their eastern tributaries, where it may be seen with a stem one hundred feet high and from six to eight feet in diameter. East of the Appalachian Mountains it is less vigorous, smaller in size, and shorter-lived, although trees eighty feet in height, with a diameter of quite three feet, are not at all uncommon. It grows most rapidly in early life and soon becomes a tree large enough for commercial purposes. Its most vigorous growth is in moist soils along low-bank streams, at the moist bases of hills and mountains, and on the borders of swamps; ground can be too wet for it, however. It will grow quite readily on poor, dry soils, if not very dry, but it there shows symptoms of failure quite early in life. It does not grow vigorously on sandy plains or on dry mountain-tops or on their sterile and dry sides. Ground rather wet for cultivation is well adapted to it. In situations at all suited, it is a very rapid grower, and not much given to developing large limbs, wherein it widely differs from its half-brother the Balm of Gilead, a species which should not be mistaken for it. It is light-demanding and any crowding by other trees will kill off its lower branches. In fact, they will die in a few years from its own shade, even when grown in the open. Its natural habit is to send up a tall, straight stem with a moderate amount of small limbs. But few of our native broadleaf trees will grow as tall in the open. It is shallow rooted, even when growing on moderately rich and moist soil.

The wood is soft, weak, and with somewhat contorted fibre. It is coarse-grained, difficult to season, with a strong tendency to warp, and shrinks greatly when drying. The heartwood is dark brown, with a very thick and nearly white sapwood. There is little difference between spring and summer wood. It is used for rough lumber, such as

sheathing where it is protected, for box boards, cheap veneers, fruit and vegetable crates, and the "Yellow Cottonwood" for flooring and cheap interior finish. It is seriously affected by atmospheric changes, where not protected by paint or varnish, as it readily imbibes moisture. It is being planted in some sections for pulp wood, for which it is admirably adapted. It is claimed that, when growing on soil adapted to it, it can be relied on to yield from three to five cords of pulp wood per acre per annum, in from seven to ten years after planting. It is not unusual for a tree to grow to a height of forty-five or fifty feet, with a diameter of twelve inches in ten years.

Propagation is best effected by inserting cuttings in the ground where the trees are to stand. This is preferable to sowing seeds, for the reason that the cuttings can be taken from trees bearing staminate flowers, thus avoiding the nuisance of the cottony floats which fill the air from trees that bear the pistillate flowers; although it is claimed that trees grown from seed are longer-lived than when propagated from cuttings. This is quite likely the case, but if the trees are to be cut for pulp wood a long life is not essential. Its habit of throwing out sprouts from its roots is very general, although there appear to be two varieties and one is more given to this than the other. Any mutilation of the roots will cause either variety to sprout. In case a sprout does not come up where a tree is wanted,—but they are generally numerous enough,—a spade can be used to cut off the roots where it is desirable for a tree to grow. The sprouts will at first grow much faster than the cuttings, as the established root system gives vigor to the sprout. A sprout has been known to grow nine feet in height the first year and a cutting seven feet.

In propagating from cuttings it is best to secure strong, healthy shoots of the previous year's growth, such as are entirely free from branches, looking well to see that the buds are well developed. The cuttings may be from three fourths down to three eighths of an inch in diameter, and

should be cut on a warm day in the last of February or the first of March. Early cutting is essential, for if the buds have swelled or the leaves have started to grow, failure is almost certain to result. Cut the shoots into lengths of eight to ten inches, with a bud near the top end. That end may be cut off square, but the other should be cut slanting, so as to give as much length as possible for "callus" to develop, for it is from this that the roots largely spring. Place the cuttings, butts downward, in moist ground in a cool cellar, or, better, out of doors, with the butts well covered with earth. Freezing will not hurt them. This is practically "heeling them in," and they should remain there until about the time the leaves of the trees in the vicinity begin to grow. Then take a pick and make a slanting hole in the ground where the tree is to stand — this hole should be at an angle of about twenty or thirty degrees from the horizontal — and insert the cutting up to the bud, leaving the latter just even with the surface of the ground. Stamp the earth down on the cutting and the operation is completed. It is absolutely necessary that the earth be packed down close on the cutting and that it and the earth should be in close contact. Nearly every one will grow if these instructions are followed, providing, however, that there is not a growth of weeds, grass, or shrubs to shade and suppress them. The author knows of a case where cuttings were planted in ground on which goldenrod grew very dense to a height of nearly four feet, and right alongside were cuttings placed in ground where there were no weeds to shade. The latter all lived and flourished; some grew four feet high the first year; while in the other ground, all started to grow, but nearly all were dead by fall.

It is impossible to indicate the distance apart that the trees should be planted. That depends largely upon the character of the soil. If the ground is rich and moist, they may be placed from six to eight feet apart; if poor and dry, five or six feet apart will be best. It has been shown by experience that twelve feet is too great a distance on dry

ground. It will be better to plant close, for it will be easy to relieve by thinning. In harvesting, it will be best to take out the largest trees first and leave some to stand for a year or two to protect the forest floor and act as "nurses" to the young shoots.

The persistency of the tree in throwing up shoots should prevent planting on lands where it is proposed to cultivate or on lawns or in streets, and the tendency of its roots to search for water should prevent planting near drains and sewers, for they will surely fill them with fibrous roots should there be an opening in them through which a tiny root can enter. The tree is sometimes attacked by borers and by oyster-shell scale — the former being the most formidable.

Swamp Cottonwood differs little from that just described. It is a smaller tree and in some sections the wood is better than that of either of the others. Its natural habitat is in the swamps, and if permitted would undoubtedly reproduce itself as far as could be desired.

Balm of Gilead is useful for pulp, but the Carolina Poplar is a much better tree. Its tendency is to branch out low down and develop an open, straggling crown, with specialized limbs, and the wood is so weak that it is frequently destroyed or badly broken by winds. It is seldom sawed into lumber. It warps badly in drying. Its cultivation as a forest tree cannot be recommended, and its habit of throwing up sprouts should prohibit its cultivation where they will interfere with cultivation of the ground or with any other use of it.

THE GUMS

THERE are three species of trees classed as "Gums," which have a commercial value for lumber. The most important of the three is commonly known as Red Gum, but it is not a Gum nor does it belong to the genus. There is nothing in common with this and the true Gums in either flowers, fruit, shape of leaves, or quality of wood. Its correct name is Liquidambar—botanically *Liquidambar styraciflua*. It is best, however, to treat it as a Gum to avoid confusion, for the lumber trade has adopted that name and by that it is commonly known.

Not until recent years was any one of the trees known as Gum esteemed of any value for merchantable lumber. Wood cut from the true Gums was soft, but not easily worked because of the interlacing of its fibres, and, what was more, that cut from all species would warp badly in seasoning. But the increasing scarcity of more valuable woods compelled consideration of the question whether such wood could not be made useful. Experiments in manufacture and treatment followed, and it was discovered that, with proper handling, lumber cut from all three species could be made quite serviceable for many purposes, decidedly so for some; and now, instead of allowing these trees to stand in the swamps or occupy ground suitable for agriculture, or to be girdled and allowed to decay and then burned,—as has been frequently done in some of the Southern States,—a large amount of lumber has been and is still being cut from them.

The uses to which this lumber has been put are many, all legitimate enough if deception is not practiced; but to ship it abroad as "Satin Walnut"—for by that name is Red Gum known in England, where large quantities of it are consumed for interior finish, furniture, and the like—

is not the right thing to do ; nor is there any justification in calling, here at home or elsewhere, any of the Gums "Satin Walnut," "Circassian Walnut," "Bay Poplar," "Hazel Pine," or "Nyssa," for that is a deception. It is true that "Nyssa" is the botanical name for all the true Gums, but the average purchaser is not likely to know that fact, and the dealer practically lies to him with a truth when he sells him Gum under that name. He might as well sell Water Oak as "Quercus." If properly manufactured and treated, all the Gums have, for the purpose for which they are adapted, merit enough to be known and sold under their true names. The three important species are Black Gum (*Nyssa sylvatica*, sometimes called Sour Gum and Pepperidge), Tupelo Gum (*Nyssa aquatica*, frequently called Cotton Gum), and Red Gum (*Liquidambar styraciflua*, in some states called Sweet Gum).

BLACK GUM : *Nyssa sylvatica*

THERE is great lack of uniformity in names given to this tree. It is known as Black Gum in fifteen states, as Sour Gum in fourteen, as Tupelo in eleven, and Pepperidge in ten. It has the greatest range of any of the species. A line drawn from the coast of southern Maine to southern Iowa, from there to southern Texas, and from there along the Gulf and Atlantic coasts, and again to Maine will inclose an area in which it may be found, but not uniformly so. It may be occasionally seen one hundred feet in height, with a diameter of four and sometimes five feet, but these dimensions are far above the average, as it is by no means uniform in growth. It has many slender limbs which are frequently drooping, but if growing in a dense stand it will show a fairly good stem free from limbs. In some sections it grows along the borders of swamps and flourishes in wet and poorly drained soils, but it is often found on high mountain slopes. Its best development is along the base of the southern Appalachian Mountains.

The wood is heavy, soft, strong, very tough, decays quickly when exposed, is difficult to season; fibres fine, but much interlaced, and hence hard to split; heartwood light brownish yellow, with sapwood lighter-colored, but very thick, showing seventy-five or eighty annual rings. It is used for wheelhubs, rollers for wire ropes, ox-yokes, crates for fruit and other like commodities that can be shipped in boxes of thin material, cut into veneers for packing up seats and panels, and also for wrapping packages where they can be rolled up, its interlaced fibre preventing splitting when thus used.

As other and more valuable species can generally be grown where this flourishes, it is manifestly better to cultivate them than to endeavor to propagate this species beyond what natural reproduction will bring about. A little care in that direction will provide all that is needed, for it is mainly used for want of better species.

TUPELO GUM: *Nyssa aquatica*

FORTUNATELY this tree is not loaded down with many names. In addition to Tupelo, it is sometimes called Sour Gum and Cotton Gum. Its botanical name indicates its aquatic character, which is very pronounced. It is the largest and most important of the genuine Gums. Its range is along the coast region from southern Virginia to northern Florida, through the Gulf States to Texas, and then up the Mississippi Valley to Missouri. It is essentially a swamp tree, growing in many places where the ground is inundated for a large part of the year. It is a frequent companion of the Bald Cypress, and like that tree has a greatly enlarged, tapering, and generally hollow base. In large trees this base may reach seven or eight feet across at the ground. It is a large, stately tree, frequently growing to a height of one hundred feet, with a diameter of four or five feet next above the enlarged base. Its branches are comparatively small, having few or no specialized limbs, and

when grown in a fairly dense stand it produces a stem free from limbs fully one half its total height.

The wood is light, moderately strong, soft, close-grained, not durable, fibres much interlaced and hence difficult to split. It takes glue, stain, paint, and varnish well. The heartwood is light brown, often nearly white, with thick, lighter-colored sapwood, which may frequently be seen composed of one hundred annual layers. It is used in the manufacture of woodenware, shipping-boxes for fruit and vegetables, handles where great strength is not required, veneers, net floats in place of cork, and furnishes more or less of the "Circassian Walnut" and "Bay Poplar." It is difficult to season, but modern methods have largely overcome that. When used where exposed to moisture, the back should be coated with paint or shellac to prevent warping.

Whether it will thrive outside of swamps, or, if so, whether it will be a profitable tree to grow beyond natural reproduction, is open to grave doubts. If confined to swamps, natural reproduction must be depended upon; and if it will grow elsewhere other and more valuable trees should take its place.

RED GUM: *Liquidambar styraciflua*

THE correct name for this tree is *Liquidambar*, but it is generally called Red Gum, and sometimes Sweet Gum. It has a wide range. A line drawn from Connecticut to Missouri and thence to Texas and the Gulf will give the boundary line on the inland side, and one from the Gulf of Mexico along the Atlantic Coast to Connecticut on the other, but it is not common north of Maryland. Its commercial range is mainly confined to the moist lands of the Ohio and Mississippi basins and of the southern and southeastern coast. It is one of the most common and one of the largest trees that occupy the hardwood bottom lands of the South. Even occasional overflowing does not seem to affect it seriously. However, it will grow on comparatively dry

ground, but does not reach so large a size there. It prefers a deep, rich soil. Its companions are Oak, Elm, Mockernut and Shagbark Hickories, White Ash, and occasionally Black Walnut.

When young and growing in the open, it forms a regular conical crown, quite like a conifer, and is frequently grown as an ornamental tree. It is emphatically light-demanding, and in this respect is as exacting as any other broadleaf tree. When grown in a stand, even moderately dense, it will send up a straight stem free from limbs to an unusual height for a broadleaf tree. There have been found trees one hundred and fifty feet high, with a diameter of five feet, but this is far above the average, as the tree varies much in size and vigor according to soil and locality. It has a peculiarity not common to other species. When it attains its height growth, its stem is much given to separating into two branches, and it then throws out a spreading crown. This forking appears to be quite general, no matter in what locality the tree may be found.

The wood is heavy, moderately hard, close-grained, stiff, fairly straight-grained, not strong, and easily worked. The heartwood is bright brown, tinged with red, with thin and nearly white sapwood. It is claimed that the heartwood is as durable as Red Oak. Its general use is for outside and interior finish for houses, for furniture, mouldings, handles, fruit and vegetable crates, veneers, and many other like purposes, and, like Tupelo, supplies "Circassian Walnut." It takes glue, stain, and paint well, and, when properly "filled" and varnished without stain, gives a satiny and transparent finish. When quarter-sawed its beauty is manifestly enhanced. While shrinking and warping badly when not properly handled, modern methods of seasoning have nearly if not quite overcome these defects. It should be known that, while the wood is only moderately heavy when dry, green logs will sink. This can be overcome by cutting them when the sap is down and letting them season for a few months.



SOUTHERN HARDWOOD FOREST, MAINLY RED GUM

Copyrighted by Clark L. Poole & Co., Chicago, Illinois.

There do not seem to be any reasonable grounds for attempting artificial reforestation. The tree has a pronounced tap-root when not growing in wet ground. This will prevent growing trees profitably in a nursery and transplanting into the forest. It is a frequent and prolific seeder, but the seedlings are so intolerant of shade that natural regeneration takes place slowly, and indications are that land must be thoroughly cleared to have that occur satisfactorily. In fact, natural regeneration fails except along the borders of open fields. Add to this the further fact that much of the land on which it grows can be rendered suitable for agriculture, and, if not, will grow more valuable trees, like Black Walnut, White Ash, and Yellow Poplar, and it will not appear advisable to undertake its cultivation beyond natural processes. While its lumber is largely used at present, mainly because of a shortage of better kinds, it is not such as to command a high price in market.

THE CATALPAS

THERE are two species of Catalpas in the United States, somewhat unlike in economic value and botanical characteristics, but bearing a close resemblance in general appearance. One is *Catalpa speciosa*, commonly called Hardy Catalpa, and the other *Catalpa bignonioides*, widely known as Bean-tree. Neither is cut into lumber to any notable extent, their value lying in the rapidity of growth and the durability of the wood when in contact with the ground. These features render them of enough importance to justify classing them with the timber trees of the country.

Catalpa speciosa was originally found only in southern Illinois, southern Indiana, western Kentucky, northwestern Tennessee, northeastern Arkansas, and eastern Missouri, but by cultivation it has been spread over a much larger area. The region of its best development is in its natural range. It is the more important of the two species, but appears to be quite variable in its character. In some sections it develops a straight stem, with a full height of one hundred and twenty feet and a diameter of four feet or more, while in others it will insist on growing crooked, with large specialized crooked branches and limbs. It prefers a rich, moist soil, such as may be found along streams and around ponds, even submitting to occasional inundations without injury. It is both light- and moisture-demanding.

It is quite probable that more Catalpa trees have been planted in this country during the last few years, than of any other forest species, but, unfortunately, success has by no means always followed the effort. It is claimed by some that the wrong species has been planted — that *Catalpa bignonioides* has been substituted for *Catalpa speciosa*. This may be the case, and largely so, too, for there is a great similarity in the trees, but it is certainly known that there

has been no mistake in some instances where practical failure has resulted. Many efforts have been made to grow the *speciosa* where climatic conditions were unsuited to it, as it cannot endure a low temperature in the winter, and it also appears to be exacting as to soil and moisture. Even where not killed outright by a low temperature, it will frequently crack open from expansion of the moisture in the wood by freezing. In many places, no doubt, the soil was too poor and dry. It frequently persists in growing crooked, and unless young trees are cut close to the ground when well established, causing a new shoot to spring up, it is very difficult to secure a straight stem. The reason of this persistency to grow crooked may be readily seen upon examination of the ends of the stem and twigs, after the winter buds are formed, where it will be found that there is seldom a terminal bud to be seen; but instead there are several gathered around the point where the central or terminal bud should be, and when they start to grow there is a contest for supremacy and a forked or crooked stem or branch is the result. If a central terminal bud has been formed, and it outgrows its close neighbors, there will then be a straight stem; otherwise a crook or fork follows. Unfortunately the central bud, if it exists, is not always the successful one. Professor C. S. Sargent¹ speaks of the Catalpa as "without terminal buds."

The wood is soft, coarse-grained, light, not strong, but very durable in contact with the soil. The heartwood is light brown, with nearly white sapwood composed of few layers, sometimes not more than three. It is used for fence posts, telegraph and other like poles, for railroad ties, and for any purpose where exemption from decay is demanded. It is doubtful if any wood is superior to it, if equal, in resisting decay when exposed to the ground. It is also used to a slight extent for interior finish and furniture, but only because better lumber is more expensive.

There is no difficulty in propagation. The tree bears

¹ *Trees of North America*, page 792.

seed early and generally annually. Its fruit — which is a pod, sometimes eighteen inches long, containing seeds with wings — hangs on until midwinter, or later, and can be easily gathered and kept, until time to plant, in the same manner in which Pine or Ash seeds are cared for. They are quite fertile, and a good stand of seedlings a foot or more high may be expected by fall. They can be successfully transplanted into the forest the following spring or allowed to remain in the seed-bed another year, but a longer period would not be advisable, as they are rapid growers in early as well as in later life. Little loss should occur in transplanting.

Any effort to plant it extensively outside of its natural habitat should be carefully considered, and it will certainly be advisable to plant a limited area at first. Experiment alone can determine whether it will succeed. The name "Hardy Catalpa" is a misnomer for a portion of the northern part of the United States. It is but little hardier than the other species, and that is known to be winter-killed in many sections. It appears to be exempt from fungus diseases, but a caterpillar destroys its leaves in some sections. In many places outside of its natural range it appears to lack vitality and dies as of old age. Any one proposing to enter upon its cultivation should secure a copy of the *United States Forest Service Circular*, No. 82, entitled "Hardy Catalpa," where its character and natural habitat and the best methods of culture are exhaustively and intelligently discussed. Its rapid growth and great durability when exposed to the soil make it a very desirable tree to grow if the right conditions of soil and climate prevail.

The other species — *Catalpa bignonioides* — is a trifle less hardy than the *speciosa*, but it will accept conditions of soil that the latter will not. Its propensity to grow branched, with crooked stem and specialized limbs, seems to be greater, if possible, than with the *speciosa*. Like that tree it is a rapid grower, and the young trees may be killed

down to the ground in winter, but they will usually spring up again, and by persistence will at last become hardy enough to grow into fair-sized trees. It is nearly as durable in the soil as the other species, and can be used for the same purposes. As an ornamental tree in an acceptable climate it is surpassed by few. It is a wonderful bloomer, being covered annually late in June with a perfect sheet of flowers, nearly white, but tinged with purple, in great clusters and so numerous that they fairly cover the ground when they fall. The seeds are in pods the same as with the *speciosa*, and gathering and caring for them as well as cultivation and planting in the forest should be the same as for the *speciosa*. It will grow fairly well from cuttings.

EUCALYPTUS

THERE are about one hundred and forty species of Eucalyptus in the world, nearly all indigenous to Australia, and none to this country. Efforts have been made to introduce some of the species here, but they have been unsuccessful, except in Arizona and southern California, where they grow well. Speculative efforts are being put forth to extend their cultivation elsewhere, but there is no probability of success, unless it may be in southern Florida or along the Gulf in southeastern Texas. Any one attempting to grow the tree outside of the regions named will undoubtedly experience a disastrous failure. Difficulties are experienced even in southern California. The tree must have a warm, moist climate and abundant water for its roots. To insure success in California the young trees must, in most cases, be irrigated until the roots penetrate the soil deep enough to obtain the needed water. It is an evergreen, but broadleaved, and requires water the year round, especially when grown in groves. The general appearance is something like that of the Lombardy Poplar, — tall, with compact, slim crown; and it presents anything but a tidy appearance when shedding its leaves and dead bark.

In favored locations it is a very rapid grower, — none more so, — and it grows from sprouts and seeds. It is not unusual for a seedling to grow ten or twelve feet in height the first year, and sprouts from a stump will exceed that. The author started one from seed in the greenhouse in April, set it out in the open in early June, and when the frost killed it in early October it was twelve feet high and one and one half inches in diameter at the butt. Plantations in Lower California can be relied on to be fit to cut for fuel at the age of five or six years from planting, when the stems will be from six to seven, or maybe eight inches

in diameter, and from forty to fifty feet in height, and practically clean of limbs for more than half their height. At ten years of age, they may reach a height of eighty, ninety, or even one hundred feet, with a diameter of ten or twelve inches. The tree sprouts freely from the stump and the plantation can be maintained in that way. It is a very valuable tree for southern California, where trees are not abundant.

The wood resembles the common Locust in general appearance, is coarse-grained, comparatively soft when green, but hard when seasoned, stiff, strong, not very elastic, and checks badly when seasoning. Efforts have been made to use it for carriagework, as in poles and shafts, but the checks persist even after they have apparently all been worked out. It is sometimes used for heavy wagon axles and other parts requiring great strength, and serves a good purpose there. While it is reported to be durable in Australia, it does not bear out that claim in this country, for it decays very quickly when exposed to the ground. If chemical treatment can be made successful, it will prove to be a very valuable tree for telegraph and the like poles, and for railroad ties and fence posts. Now it is used for little else than fuel, for which it serves a good purpose, and it is a profitable tree to grow for that in its chosen habitat. It also provides a good wind-break for the protection of fruit trees and farm crops. When studying the trees of the Pacific Slope a few years ago, the author would inquire, wherever it was found abundant, "For what purpose is it grown?" The answer invariably was, "For fuel." "Anything else?" "Yes, they make an ointment from its leaves." "Is that all?" Ordinarily, "Yes." One old resident, however, ventured a little further. He said, "Just to have trees." That shows the estimate put upon it by those who have had practical experience with it. The best of the two species cultivated in California is known as *Eucalyptus globulus* — so named from its round fruit. It is called there "Blue Gum," or just plain "Gum." Unless some

new use, not now known, for the wood is discovered, it should not be classed among valuable trees, except in Arizona and southern California. Its propagation from seed is somewhat difficult, but in that mild climate it is not insurmountable.

BROADLEAF TREES OF THE PACIFIC SLOPE

WHILE the Pacific Slope is the home of many of the largest coniferous trees in the United States, and, for that matter, in the world, some of which rank among the highest in importance in the lumber trade, — the region is favored with but few broadleaf species that can be favorably compared with those east of the Rocky Mountains. In fact, none are quite equal to the eastern relatives. Some of them, however, are important to that region because they are indigenous to it, and in some localities fairly abundant, and furnish a fair grade of lumber at a less price than the eastern hardwoods can be delivered for. A brief account of the best of them is here given, taken, in part, from *Forest Trees of the Pacific Slope*, by George B. Sudworth, dendrologist of the Forest Service of the United States, combined with the author's personal observations when studying the timber trees of that region.

Poplars. Under this head may be classed the Cottonwoods and the Aspens. These are substantially the same in general character as the Eastern species and the uses they can be put to are practically the same. The Cottonwoods are found along the low grounds of the valleys and in the moist sandy soils. The Aspens seek the higher and drier slopes and elevations. Little use is now made of either, but as pulp wood becomes exhausted in the East and other species of timber trees grow less abundant in the extreme West, these woods may be profitable to plant; but the ample supply of other and better ones will not justify that effort at the present time.

The Oaks. There are fourteen species of Oaks on the Pacific Slope. All of them can be found in California and

few of them elsewhere. Some are magnificent trees, in an æsthetic sense, with immense short stems and large crooked branches and picturesque crowns ; but the wood is very inferior in most of them, decaying quickly, splitting badly in drying, and is not even first-class fuel. This is especially so with the Valley White Oak (*Quercus lobata*), which may be seen nearly the entire length of California, growing far apart and, in some sections, with moss drooping from its limbs somewhat similar to the moss on some of the trees of the South Atlantic and Gulf States. Only two of them can be considered of enough importance to warrant attempts at cultivation.

Garry Oak. This is sometimes called White Oak. Its botanical name is *Quercus garryana*. It grows on elevations from near sea level to three thousand or four thousand feet above, from Vancouver Island to central California. It is the most valuable timber Oak in the Northern Pacific Coast region. In its best development it grows from seventy-five to ninety feet high, but usually from fifty to sixty feet, and from eighteen to thirty inches in diameter, with a short, clean stem and a broad, round crown ; but on high mountain-slopes it dwindles to a shrubby tree. The wood is hard, fine-grained, tough, strong, and stiff, heartwood light yellowish brown with thin, nearly white sapwood, and suitable for nearly the same general purposes for which standard grades of Eastern White Oak are employed. It belongs to the White Oak Class, and matures its seed in one year. It is a prolific seeder every two years. Having a tap-root, it is probable that planting acorns will be the best method of reproduction. It cannot be learned that any attempt has been made to cultivate it. It is light-demanding but will endure a slight shade in early life. Germination of naturally sown seeds does not appear to occur readily, especially on grassy surfaces where the seeds generally fall. Seedlings are rarely seen there. They are most frequent on moist humus soil and litter. Being the most important

Oak in the region west of the eastern foothills of the Rocky Mountains, efforts should be made to cultivate it, — at all events, to encourage natural reproduction.

Tanbark Oak. Strictly speaking, this tree is not an Oak, but a link between an Oak and a Chestnut. Its leaves resemble those of the Chestnut, even more so than do those of the eastern species of Chestnut Oak, while the acorns are similar to those of an Oak, and it takes two years for them to mature. It is the only one of its genus on this continent, though there are several in China and Japan. It is classed, however, as an Oak by lumbermen, and for all practical purposes such classification is not objectionable. It is botanically known as *Pasania densiflora*. It is not a first-class timber tree, but is worthy of consideration in a region where there are few useful hardwoods, and where the extensive use of its bark for tanning adds to its value. Its range is from southwestern Oregon to southern California, generally at from sea level to four thousand and five thousand feet elevation. It is seldom found over seventy-five feet in height and two feet in diameter, but larger trees are occasionally met with. On high elevations it may not exceed ten feet in height, and its characteristics there are so modified as to raise question as to its identity.

The wood is dense, fine-grained, strong, very hard, brittle, — this latter feature varying with age, — reddish brown, with thick, darker-brown sapwood. The wood is now mainly used for fuel and the bark for tanning, although the wood, if properly treated, would do well for interior finish, furniture, and many other purposes. It is now being recklessly cut and destroyed, mainly for the bark. Little or no effort appears to have been made to care for its preservation and none towards its cultivation. It is a prolific seeder and the seedlings stand considerable shade. It sprouts vigorously from the stump, producing permanent stems. With proper treatment there is no doubt but that natural reproduction would maintain an abundant supply.

Broadleaf Maple. Of the four species of Maple growing on the Pacific Slope, only this has any economic value as a timber tree. It is quite frequently called "Bigleaf Maple" and "Oregon Maple." Botanically it is known as *Acer macrophyllum*. Its range is from northern Washington to southern California, along borders of foothills and low mountain streams, in moist, gravelly, and rich humus soils. Its climatic requirements are those of the Douglas and other Firs. It forms practically pure stands over large areas, but is often mixed with Lowland Fir. It is light-demanding, and when in dense stands grows straight and quite free from limbs. It attains a height of from sixty to eighty feet with a diameter of from fifteen to thirty inches, sometimes larger, but when in the open, it is short-stemmed, crooked, and practically worthless for lumber.

The wood is fine-grained, rather hard, firm, not strong, heartwood light brown, with pale reddish tint, and thick lighter-colored sapwood. It is largely used for interior finish, furniture, and general purposes, in which it compares quite favorably with the Hard Maples of the Eastern States. It is a tree of first importance in the region where it grows. Whether it will flourish outside of its natural habitat is problematical. It may be as exacting in climatic conditions as is its frequent companion the Douglas Fir. It is a rapid grower, forest-grown trees fifty to eighty years of age attaining a diameter of twelve to twenty inches, averaging an annual layer of one eighth of an inch in thickness. It sometimes reaches an age of two hundred years.

While no efforts are known to have been made to cultivate it for any other than ornamental purposes, there is no question but that it can be readily grown as a forest tree in its natural habitat. It is a good seeder and germination takes place quite well naturally, although growing plants in a nursery would more certainly result in a satisfactory stand. Its great importance as a timber tree renders its cultivation highly desirable.

Oregon Ash. This is the only Ash of importance in the Pacific Coast region. Its botanical designation is *Fraxinus oregona*. It may be found from the shores of Puget Sound south to San Francisco and along the foothills of the Sierra. In most favored localities forest trees have long, clean stems, and narrow, short crowns of small branches, and are from sixty to seventy-five feet in height, and from sixteen to thirty inches in diameter, sometimes larger.

The wood is substantially like the White Ash of the Eastern States. The heartwood is a dull yellowish brown, with whitish sapwood. In forest-grown trees it is moderately brittle and fine-grained, but in open-grown trees it is elastic and coarse-grained, particularly in the sapwood of young trees. The wood is not so heavy as that of our Eastern Ashes, but for general usefulness it compares very favorably with them, and in the main will serve for the same economic purposes.

It is a good seeder, but the staminate and pistillate flowers are borne on separate trees, and hence, in gathering seed, care should be taken to see that they are fertile. Natural reproduction is fairly good, if on suitable soil, which is that of alluvial bottoms and flats, and in this it maintains the character of its eastern relative the White Ash. Whether it has a largely developed tap-root, as most Ashes have, or, if so, whether it can be deprived of it without serious consequences, as in the case of the White Ash, the author does not know. If it possesses no tap-root or if it has a tap-root that can be removed without serious results, it can, no doubt, be successfully grown in the nursery and transplanted into the forest; otherwise planting seeds must be resorted to. It is a fairly prolific seeder, with a high percentage of fertility. It makes a rapid height growth in early life. Forest-grown trees from sixteen to twenty-five inches in diameter are from ninety-five to one hundred and fifty-five years old. As age creeps on, they grow more slowly. It certainly is worthy of an attempt at cultivation as a forest tree.

Red Alder. There are six species of Alder in the United States, and only one of them is of any commercial value. The common name of that one is Red Alder, and it is botanically known as *Alnus oregona*. It may be found growing from Puget Sound and the southwestern part of Washington, in Oregon, and along the Pacific Coast of California from the Oregon line to Santa Barbara. It is a broadleaf deciduous conifer. It may be found from eighty to ninety feet in height, with a diameter of eighteen to thirty inches, although far more commonly only forty to fifty feet high and twelve to fifteen inches through. It is light-demanding, and when grown in dense stands, sends up a straight stem, with small, slim, drooping limbs in the crown. The seedlings can endure considerable shade.

The heartwood is soft, somewhat brittle, not strong, close-grained, light brown tinged with red, with very thick and nearly white sapwood when newly cut, but which turns to a red-brown soon after. This discoloration comes from the large amount of tannic acid in the wood, a sample of which, secured by the author, showed, on analysis, 8.45 per cent of tannin. It shows a fine satiny surface when properly treated, and can be used for interior finish and furniture. Some fine samples of the finished wood were on exhibition at the Lewis and Clark Exhibition at Portland, Oregon.

It is a prolific seeder, and if care were taken to thin dense natural stands, it would, no doubt, be profitable to grow it for lumber alone, for it is a rapid grower for the first twenty-five or thirty years of its life, trees running from ten to eighteen inches in diameter at twenty-five to fifty years of age, while the large amount of tannin the wood contains will add to its value when other sources for that necessary commodity fail. It attains its largest size along the coast, and flourishes best in a moist, fertile soil and a humid atmosphere.

Western Chinquapin. No doubt this tree has been called a Chinquapin because of the resemblance of its fruit

to that of the Chinquapin of the Southern States, a tree which belongs to the Chestnut family. But it is neither a Chestnut nor a Chinquapin, and is the only one of its kind on this continent. Its botanical name is *Castanopsis chrysophylla*. It is sometimes called "Golden Chestnut." It is an evergreen, shedding its leaves at the end of the second or third year. It is scattered throughout Washington, Oregon, and California, but the region of its large growth is comparatively small, as in much of its range it gets but little above pole dimensions, and on high elevations is practically a shrub. Its largest and best development is in northwestern California among the Redwoods, in the moist, mild air of that region. It sometimes attains a height of one hundred feet, with a diameter of three to four feet, — larger dimensions are reported, — but ordinarily it reaches only fifty to sixty feet in height and eight to fifteen inches in diameter. It is of rather slow growth, trees from eighteen to twenty-five inches in diameter ranging from one hundred and forty-five to one hundred and ninety years of age.

The wood is light, fine-grained, not strong, rather soft and somewhat brittle, pale reddish brown, with lighter-colored sapwood of fifty to sixty-five annual layers. The bark is rich in tannin. Large trees furnish excellent saw timber which is suitable for agricultural implements and like purposes. Its seed is a small sweet nut inclosed in a burr somewhat like that of a Chestnut and it requires two years to mature. It is a prolific seeder, but the little nuts are largely consumed by animals. It is not known that any attempt has been made to cultivate it. No doubt its propagation can be made successful, but whether by planting seeds or growing young trees in the nursery can be known only after experiment. It is evident that any attempt, outside of the range of its best development, will be useless, for it is essentially a lover of a moist atmosphere and a mild climate, flourishing only where such conditions exist.

APPENDIX

APPENDIX

I

GLOSSARY OF SCIENTIFIC NAMES OF SPECIES OF TREES

- Acuminata*. Tapering to a point.
Alba. White.
Amabilis. Amiable, lovely.
Angustifolia. Narrow-leaved.
Aquatica. Of the water, aquatic.
Balsamifera. Balsam-producing.
Bignonioides. Bignonia-like.
Canadensis. Canadian.
Cinerea. Ashy-gray.
Coccinea. Scarlet.
Concolor. Of one color.
Contorta. Twisted.
Deltoides. Delta-shaped (as to leaves).
Densiflora. Densely flowered.
Dentata. Toothed (as to leaves).
Digitata. Having fingers (leaflets resembling fingers).
Distichum. Of two rows (as to leaves).
Divaricata. Spread out (having abrupt or right-angled branches, straggling).
Echinata. Prickly.
Engelmanni. Named for Engelmann.
Europea. European.
Excelsa. Tall, lofty.
Glabra. Smooth, without pubescence.
Globulus. Round (as to fruit).
Grandidentata. Deeply dentated (as to leaves).
Grandis. Grand.
Heterophylla. Variable-leaved.
Laciniosa. Jagged (as to leaves).

- Lambertiana*. Named for Lambert.
Lanceolata. Lance-shaped (as to leaves).
Lenta. Pliant.
Lutea. Yellow.
Lyallii. Named for Lyall.
Lyrata. Lyre-shaped (as to fruit).
Macrocarpa. Large-fruited.
Macrophyllum. Large-leaved.
Magnifica. Magnificent.
Michauxii. Named for Michaux.
Minor. Smaller.
Monticola. Mountain-inhabiting.
Nobilis. Noble.
Occidentalis. Western.
Ovata. Egg-shaped (as to fruit or leaves).
Pagodaefolia. With pagoda-like leaves.
Palustris. Marsh-loving.
Papyrifera. Paper-bearing.
Pennsylvanicum. Of Pennsylvania.
Platanoides. Plane-tree-like.
Plicata. Folded.
Ponderosa. Heavy.
Prinus. Latin name for a species of Oak.
Pseudacacia. False Acacia.
Pubescens. Downy (as to leaves).
Quadrangulata. Four-angled.
Racemosa. With racemes (the simplest form of elongated flower-cluster).
Resinosa. Resinous.
Rigida. Stiff (as to leaves).
Rubens. Reddish.
Rubra. Red.
Saccharinum. Sugary.
Saccharum. Sugary.
Sempervirens. Evergreen.
Serotina. Late (as to flowering).
Speciosa. Beautiful, showy.
Strobus. The name of an incense-bearing tree of Persia, mentioned by Pliny.
Styraciflua. Gum-exuding.

Sylvestris. Of the woods.

Tæda. Resinous, pitchy.

Taxifolia. Yew-leaved.

Thyoides. Resembling *Thuya*.

Tinctoria. Pertaining to the dyer.

Tremuloides. Resembling *Tremula* (*Populus tremula*, the European aspen).

Triacanthos. Three-thorned.

Tulipifera. Tulip-bearing.

Velutina. Velvet-like.

Virginiana. Of Virginia.

II

THE AVERAGE HEIGHT WHICH SEEDLINGS OF DIFFERENT SPECIES REACH IN ONE AND TWO YEARS

THE following Table shows approximately the height which seedlings of the different species named attain in one and two years. Conditions of soil, location, and climate naturally operate to modify the figures given. In all cases there are extremes both ways even in close association.

Species	One year inches	Two years inches
White Pine	1½	2½
Western White Pine	1½	2
Sugar Pine	2	4
Longleaf Pine	1½	2
Cuban Pine	4	8
Shortleaf Pine	4	6
Old-Field Pine	7	12
Western Yellow Pine	1½	4
Red Spruce	1	2
White Spruce	1	2½
Engelmann Spruce	1½	5
Norway Spruce	1	5
Fraser Fir	1½	4
Balsam Fir	1	2½
Douglas Fir	1½	3
Hemlock	1	1½
White Cedar	1	1½
European Larch	1½	5
White Oak	3	6
Overcup Oak	6	10
Burr Oak	6	10
Red Oak	5	8
Black Oak	4	9
Pin Oak	5	12

Species	One year inches	Two years inches
White Ash	8	16
Red Ash	7	14
Shagbark Hickory	4	9
Shellbark Hickory	3	8
Mockernut Hickory	5	10
Pignut Hickory	4	8
Sugar Maple	4	6
Silver Maple	8	18
Red Maple	8	15
Yellow Poplar	5	15
Chestnut	4	10
White Elm	6	20
Red Elm	8	20
Cork Elm	6	15
Basswood	4	10
Black Birch	2	4
Yellow Birch	4	8
Beech	4	10
Black Walnut	8	15
Butternut	10	15
Locust	4	9
Honey Locust	5	15
Sycamore	6	18
Red Gum	8	15
Catalpa	8	15

III

APPROXIMATE RANGE IN THE PERCENTAGE OF GERMINATION FOR TWENTY-SIX IMPORTANT SPECIES¹

Name of species	Percentage of germination in fresh seed	
White Pine	70	to 90
Longleaf Pine	60	85
Shortleaf Pine	50	75
Loblolly Pine	50	80
Western Yellow Pine	60	80
Red Spruce	60	75
Bald Cypress	25	50
White Oak	75	95
Chestnut Oak	75	95
Burr Oak	75	95
Red Oak	60	80
White Ash	35	50
Shagbark Hickory	50	75
Shellbark Hickory	50	75
Mockernut Hickory	50	75
Pignut Hickory	50	75
Sugar Maple	30	50
Yellow Poplar	5	10
Chestnut	75	95
Black Cherry	75	80
White Elm	50	75
Cork Elm	50	75
Black Walnut	75	80
Honey Locust	50	75
Sycamore	60	75
Catalpa	40	75

¹ From *United States Forest Service Bulletin*, No. 29, "The Nursery," page 36.

IV

NUMBER OF TREE SEEDS PER OUNCE AND POUND, AND ALSO THE APPROXIMATE NUMBER OF LINEAR FEET OF SEED DRILL COVERED BY EACH QUANTITY¹

Species	Number of seeds in one ounce	Number of seeds in pound	Covered by one ounce	Covered by one pound
White Pine	1,800	28,800	36	576
Red Pine	4,700	76,160	75	1,200
Shortleaf Pine	4,900	79,840	80	1,280
Western Yellow Pine	100	1,600	16	256
Norway Spruce	5,260	84,160	75	1,200
Red Fir	4,200	67,200	60	960
Bald Cypress ²	320	5,120	20	320
Honey Locust	200	3,200	16	256
Hardy Catalpa	1,230	19,680	60	960
White Ash	640	10,200	25	400
Sugar Maple	470	7,498	20	320
Black Cherry	279	4,464	20	320
Basswood	397	6,352	20	320
White Elm	5,820	93,120	125	2,000
Red Elm	3,398	54,368	80	1,280

¹ Copied from *United States Forest Service Bulletin*, No. 29.

² About fifty per cent of the bulk of Cypress seed in the trade consists of refuse shells of cones.

INDEX

INDEX

- Abies amabilis* (lovely fir), 194, 195.
Abies balsamea (balsam fir), 190, 191.
Abies concolor (white fir), 193, 194.
Abies fraseri, 189, 190.
Abies grandis (white, or grand fir), 192, 193.
Abies magnifica (red fir), 197, 198.
Abies magnifica shastensis, 197.
Abies nobilis (noble fir), 195, 196; why once called a larch, 195.
Acer macrophyllum (broadleaf, or Oregon maple), 276, 354.
Acer nigrum (black maple), 276-280.
Acer rubrum (red maple), 282.
Acer saccharinum (silver, or soft maple), 280, 281.
Acer saccharum (sugar maple), 276-280.
Age, at which trees should be harvested, 53 ff.; proper, for transplanting, 112, 113.
Alder, red. See *Alnus oregona*.
Alnus oregona (red alder), 356.
Annual rings, 71, 72.
Arborvitæ, species of, 210. See *Thuja occidentalis* and *T. plicata*.
Artificial reforestation. See Reforestation, artificial.
Ash, black. See *Fraxinus nigra*.
Ash, blue. See *Fraxinus quadrangulata*.
Ash, green. See *Fraxinus lanceolata*.
Ash, Oregon. See *Fraxinus oregona*.
Ash, red. See *Fraxinus pennsylvanica*.
Ash, white, 354. And see *Fraxinus americana*.
Ashes, the, species that produce merchantable lumber, 258. See various species under *Fraxinus*.
Aspen, largetooth. See *Populus grandidentata*.
Aspen, trembling, 39, 178. And see *Populus tremuloides*.
Aspens, two species of poplar so-called, 332; on Pacific slope, 351.
Austria, revenue of national forests in, 18 n.
Baden, revenue of national forests in, 18 and n.
Baker, Hugh P., quoted, 223, 224.
Balm of Gilead. See *Populus balsamifera*.
Balsam, Canada, 190.
Balsams. See *Abies balsamea* and *A. fraseri*.
Bark, protective function of, 67; growth of, in tree-life, 71; changes in, 74, 75, 76; "live" and "dead," 75; useful ingredients of, 75; species easily distinguished by, 76.
Barnyard manure, 105.
Basswood. See *Tilia americana*.
Basswood, downy. See *Tilia pubescens*.
Basswood, white. See *Tilia heterophylla*.
Basswoods, species of, 302.
Bastard sawing, 86.
Bavaria, revenue of national forests in, 18 and n.; investigations in as to comparative demands of trees and crops on the soil, 36.
Bean tree. See *Catalpa bignonioides*.
Beech. See *Fagus americana*.
Beech, red, 310, 311.
Beech, white, 310.
Betula lenta (black birch), 306, 307.
Betula lutea (yellow, or gray birch), 307, 308.
Betula nigra (red, or river birch), 306.
Betula papyrifera (paper, or canoe birch), 308, 309.
"Big stockings," 328.
Big tree, 199. And see *Sequoia washingtoniana*.
Big-bud hickory, 273.
Birch, black, 291. And see *Betula lenta*.
Birch, canoe. See *Betula papyrifera*.
Birch, cherry, 291. And see *Betula lenta*.
Birch, gray. See *Betula lutea*.
Birch, paper. See *Betula papyrifera*.

- Birch, red. See *Betula nigra*.
 Birch, river. See *Betula nigra*.
 Birch, sweet. See *Betula lenta*.
 Birch, yellow. See *Betula lutea*.
 Birches, the, economically important species of, 306. And see under *Betula*.
 Bird's-eye maple, 278.
 Birds, methods of protecting seeds from, 98.
 Bitternut, 274.
 Black Jack, 251.
 "Blisters," 190.
 Bone, ground, 105, 106.
 Botanical range. See Range.
 Brainiff, Edward A., quoted, 56.
 Broadcast sowing, one method of artificial reforestation, 26, 27; in nursery, 93-95.
 Broadleaf trees, should they be mingled with conifers? 44, 45; in treeless regions, 52; transplanting less important for, than for conifers, 111, 112; of the Pacific Slope, 351-357.
 Buds, in tree-life, 63.
 Burning, best method of treating land covered with worthless trees, 39, 40.
 Butternut. See *Juglans cinerea*.
 Buttonball. See *Platanus occidentalis*.
 Buttonwood. See *Platanus occidentalis*.
 Cambium layer, the, between wood and bark, 67, 71, 74; a storehouse for food, 71; experiment with, 75, 76.
 Canada, forest products of, not available for U. S., 9; and the exportation of wood-pulp, 9; forest products of, 128.
Castanea dentata (chestnut), 239, 286-290; disastrous fungus disease of, 290.
Castanopsis chrysophylla (western chinquapin), 356, 357; not really a chinquapin, 357.
 Catalpa, 294 n.
Catalpa bignonioides (bean tree), 346, 347.
 Catalpa, hardy. See *Catalpa speciosa*.
Catalpa speciosa (hardy catalpa), 344-346.
 Catalpas, the, species in U. S., 344.
 Cedar, red. See *Juniperus virginiana*, and *Thuja plicata*.
 Cedar, western red. See *Thuja plicata*.
 Cedar, white. See *Thuja occidentalis*, and *Chamaecyparis thyoides*.
 Cedars, species so misnamed, 207.
Century Dictionary, "grain" and "fibre," how defined in, 80.
Chamaecyparis thyoides, 212.
 Checking, 82, 83, 84.
 Cherry. See *Prunus serotina*.
 Cherry, black, 306. And see *Prunus serotina*.
 Cherry, rum. See *Prunus serotina*.
 Cherry, wild. See *Prunus serotina*.
 Chestnut, may recur in second growth, 18. And see *Castanea dentata*.
 Chestnut, "golden," 357.
 Chinese, and the sugar pine, 149.
 Chinquapin, western. See *Castanopsis chrysophylla*.
 Chinquapin oak. See *Quercus acuminata*.
 Chlorophyl, 66, 69.
 Clean-cutting, 22.
 Clements, F. E., *Plant Physiology and Ecology*, quoted, 68.
 Close-grained, 81.
 Coal, world-supply of, its probable duration, 10, 58.
 Coarse-grained, 81.
 Color, of wood, an element of value, 85.
 Cones, described, 133; of *Pinus strobus*, 140, 141.
 Conifers, grown in nursery, when transplanted, 29; should they be mingled with broadleaf trees? 44, 45; in treeless regions, 52; the lumberman's "softwoods," 79; importance of transplanting, 111, 112, 113; their early growth slow, 112.
 Conservation of forests. See Forests.
 Conservation of natural resources, need of, 3, 4.
 Conservation cutting. See Selective cutting.
 Cottonwood. See *Populus deltoides*.
 Cottonwood, swamp. See *Populus heterophylla*.
 Cottonwood, yellow, 339.
 Cottonwoods, other species known as, in U. S., 332 ff.; on Pacific slope, 351.
 Cross-grained, 81.

- Crown development, 65.
 Cucumber. See *Magnolia acuminata*.
 Cultivation of plants in forest nursery, 100 ff.
 Cut-over forests, seldom consist of original species, 18.
 Cut-over lands, 14, 42.
 Cutting. See Improvement cutting and Selective cutting.
 Cypress, only one American species of commercial value, 215.
 "Damping-off," in nursery, how treated, 102; prevention the only remedy, 102.
 Decay, caused by disease, 84.
 Deciduous trees. See Trees, deciduous.
 Diameter of trees at various ages, 54.
 Douglas squirrel, the, 149.
 Downing, A. J., 205.
 Drills, sowing in, in nursery, 95-97; statistics concerning, 367.
 Droughts, caused by absence of forests, 8.
 Drying, effect of, on different classes of seeds, 116-118. And see Seasoning.
 Dry-kilns, uses of, 84.
 "Eaty" fibre, 77.
 Elm, cedar. See *Ulmus crassifolia*.
 Elm, cork, 297. And see *Ulmus racemosa*.
 Elm, gray. See *Ulmus americana*.
 Elm, hard, 300.
 Elm, red, 297. And see *Ulmus pubescens*.
 Elm, rock, 300.
 Elm, slippery. See *Ulmus pubescens*.
 Elm, weeping, 300.
 Elm, white. See *Ulmus americana*.
 Elms, the, species indigenous in U. S., 296. See under *Ulmus*.
 Engelmann spruce. See *Picea engelmanni*.
 England. See Great Britain.
 Erosion, of soil, usually follows destruction of forests, 8; effect of, on reforestation, 8, 9; ultimate effect of, 9; degree of, important in denuded land, 38; in farm lands, 59, 60.
 Eucalyptus, none of the many species of, indigenous in U. S., 348; two species successfully introduced in Arizona and California, 348.
Eucalyptus globulus, 349.
 Europe, consumption of forest products in, 128.
 Evaporation, 31.
 Evergreens, include both soft and hard woods in lumbermen's classification, 79; fall planting of, 121.
 Exogens, the only real timber trees, 71.
Fagus americana (beech), 310-312; but one species in U. S., 310, 311; fungus disease of, 312.
 Farm purposes, growth of trees for, 58 ff.
 Farmer, the, must grow trees, 59.
 Farms, lands suitable for tree-growth on, 59, 60.
 Female flowers, 64.
 Fernow, B. E., *Economics of Forestry*, 36 n., 179 n.
 Fertilizers, in the nursery, 104-106.
 Fertilizing, for nursery, 90 and n., 92.
 Fibre, defined, 80, 81; strength of, 82. And see Grain.
 Fields, abandoned, tree-planting in, 41.
 Fine-grained, 81.
 Fir, alpine, 193.
 Fir, amabilis. See *Abies amabilis*.
 Fir, Douglas. See *Pseudotsuga taxifolia*.
 Fir, grand. See *Abies grandis*.
 Fir, lovely. See *Abies amabilis*.
 Fir, noble. See *Abies nobilis*.
 Fir, red, 195. And see *Abies magnifica*.
 Fir, white. See *Abies grandis* and *A. concolor*.
 Fir, yellow, 199.
 Fire cherry, 39.
 Fires in forests, 8.
 Fires, species of, in U. S., 189; their distinguishing feature, 189; real economic value of, 198; their probable future, 198. See the various species under *Abies*.
 Fires, eastern. See *Abies balsamea* and *A. fraseri*.
 Fires, western, species of, 191 and n. And see *Abies amabilis*, *A. concolor*, *A. grandis*, *A. magnifica*, *A. nobilis*.
 Flat sawing, 86.
 Floods, caused by absence of forests, 8.
 Flowers, in tree-life, 63, 64; "perfect," pistillate, and staminate, 63,

64. And see Female flowers and Male flowers.
- Forbes, A. C., *Development of British Forestry*, quoted, 47 n.
- Forest, history of an average, 17 ff.; when plants should be set in, 121, 122; spacing plants in, 123 ff.
- Forest, second-growth, 14; need and methods of increasing productiveness of, 15, seldom consists of original species, 18.
- Forest, virgin, area of, being rapidly reduced, 14; main source of supply of forest products, 14; possible increased capacity of, 14, 15; need of conservative treatment of, 15; removal of mature trees from, 15; selective and improvement cutting in, 16; different species of trees in, 43, 44; pure and mixed stands in, 44.
- Forest crown, the, 33, 34.
- Forest floor, the, defined, 32; its proper maintenance of great importance, 32, 33.
- Forest nursery. See Nursery, forest.
- Forest products, essential to modern civilization, 8; not to be supplied by other countries, 9; and the exhaustion of the coal supply, 10; no possible substitute for, 10; statistics of, in U. S., for 1909, 10; other statistics of, 12; great sums of money used in exploiting, 12; forecast of future cost of, 127, and future price of, 127, 128; probable increased demand for, 128, 129; consumption of, in Europe, Asia, and Canada, 128.
- Foresters, differ as to mingling species, 45.
- Forestry, practical, importance of, 4; a science, 5; neglect of study of, 5, 6; principal effort in, should be directed to tree-growing, 6, 7; connotation of term, 15; little understood, though a simple science, 15.
- Forestry departments, state, 114.
- Forests, possibilities of conservation of, 3, 4; present rate of consumption of, 4 and n.; danger of exhaustion of, 4, 5; pressing need of conservation of, 5; careless destruction of, 6; effect of presence or absence of, on water-courses, 8; how treated by lumbermen and others, 8; no seed trees left in, 8; destruction of, usually followed by fire, 8; in Canada and Europe, 9; in U. S., condition of, to-day, compared with condition in Germany and France two centuries ago, 13, 21; treatment of mature and immature trees in, 15, 16; selective and improvement cutting in, 15, 16; net annual revenue of (national), in Europe and U. S., 18 and n.; and increased rainfall, 31. And see Forest, second-growth, Forest, virgin, Forest products, and Trees.
- Forests, mixed, 43 ff.
- France, forests in, 9, 13, 21; successful reforestation in, 13; revenue of national forests in, 18 and n.
- Fraxinus americana* (white ash), 258-262. Cut of seedling, opp. 64; cut of section, opp. 72; cut of planted trees, opp. 96.
- Fraxinus lanceolata* (green ash), 263, 264.
- Fraxinus nigra* (black ash), 266, 267.
- Fraxinus oregona* (Oregon ash), 355.
- Fraxinus pennsylvanica* (red ash), 262, 263.
- Fraxinus quadrangulata* (blue ash), 264-266.
- Fruit, of trees, 86.
- Fuel, growth of trees for, 58; amount of wood used for, in U. S., 58.
- Fuller, Andrew S., 218.
- "Fungus of the cutting bench." See "Damping-off."
- Gas, probable duration of supply of, 58.
- Germany, forests in, 9, 13, 21; successful reforestation in, 13.
- Germination, in tree-life, 65, 66; how aided in nursery, 98, 99; percentage of, for 26 species, 366.
- Giant arborvitæ. See *Thuja plicata*.
- Gleditsia triacanthos* (honey locust), 323-325; not a locust, 323.
- Grass, on forest floor, 34; planting trees in, 41.
- Grain of wood, irregularity of direction of, a mystery, 76-78; kinds of irregularities of, 76, 77; meaning of term, 80, 81. And see Close-, Coarse-, Cross-, Fine-, and Straight-grained.

- Great Britain, condition of forests in, 9.
- Green, Samuel B., 167.
- Ground, preparation of, for nursery, 90-92.
- Growing young trees in a nursery. See Nursery.
- Gum, black. See *Nyssa sylvatica*.
- Gum, blue, 349.
- Gum, cotton, 339, 340.
- Gum, red. See *Liquidambar styraciflua*.
- Gum, sour, 339, 340.
- Gum, sweet, 339, 341.
- Gum, tupelo, 77. And see *Nyssa aquatica*.
- Gums, species of, 338, 339. See under *Nyssa*.
- Hackmatack (tamarack), 220.
- Hardwood, in lumbermen's classification, 79, 80; its meaning in this book, 80.
- Harvesting, proper age and dimensions for, 53 ff.
- Heartwood, formation of, 72; nature of, 73; moisture in, 82, 83.
- "Heeling-in," in the nursery, 108, 109.
- Hemlock, eastern. See *Tsuga canadensis* and *T. caroliniana*.
- Hemlock, western. See *Tsuga heterophylla*.
- Hemlock bark, tannic acid (tannin) in, 75, 203.
- Hemlocks, the, impending exhaustion of, 12; species of, indigenous in U. S., 203; general characteristics of, 203; tannin in bark of, 203. See species under *Tsuga*.
- Hesse, revenue of national forests in, 18 and n.
- Hickories, the, species of, indigenous in No. America, 268, 269; classes of, in commerce, 268; use of, in carriage-work, 268, and for smoking meat, 268; characteristics of, 269. See species under *Hicoria*.
- Hickory, 306.
- Hickory, black, 268.
- Hickory, mockernut. See *Hicoria alba*.
- Hickory, pignut. See *Hicoria glabra*.
- Hickory, shagbark, 269, 272. And see *Hicoria ovata*.
- Hickory, shellbark, 268. And see *Hicoria laciniosa*.
- Hicoria alba* (mockernut), 273, 274; many names of, 273.
- Hicoria glabra* (pignut), 274, 275.
- Hicoria laciniosa* (shellbark), 272, 273.
- Hicoria minima*, 274.
- Hicoria ovata* (shagbark), 270-272.
- Hicoria pecan*, 269.
- Holmes, O. W., *The Professor at the Breakfast-Table*, 297.
- Homer, 260, 310.
- Honey locust. See *Gleditsia triacanthos*.
- Humus, what it is, 32; its utility in fertilizing soil, 32, 33. And see Muck.
- Immature trees. See Trees.
- Improvement cutting, 15, 16.
- India, 128.
- Indians, and the sugar pine, 149.
- "Intolerant" trees, defined, 35; mingling of, with tolerant, 45.
- Investment in forests, when interest on, exceeds value of accretion, 56, 57.
- Irrigation in forest nursery, 100, 101.
- Italians, and the sugar pine, 149.
- Italy, revenue of national forests in, 18 n.
- Japan, 128.
- Juglans cinerea* (butternut), 317, 318.
- Juglans nigra* (black walnut), 313-316.
- Junipers, wrongly called cedars, 207; the most widely distributed species of tree in America, 207; only one variety valuable as timber tree, 207.
- Juniperus virginiana* (red cedar), 207, 208.
- Kainit (fertilizer), 106.
- King-nut, 272.
- Land, once wooded, proper field for reforestation, 16; four classes of, subject to reforestation, 38-41.
- Larch, European. See *Larix europæa*.
- Larch, western. See *Larix occidentalis*.
- Larches, species of, 219.
- Larix europæa* (European larch), 223-

- 225; much used for posts and telegraph poles, 223, 224.
Larix laricina (tamarack), 219-221.
Larix occidentalis, 221, 222.
 Leaf, development of, in tree-life, 68 ff.; venation of, 68; skin of, 68; stomata, 69, 70.
 Life-history of a tree, 63 ff.
 Light, essential to tree-growth, 35; all trees do not require equal amount of, 35; tolerant and intolerant trees, 35; all trees require more, in old age, 36; essential to functioning of stomata, 70; struggle of stems for, 71.
 Linden, European name for basswood, 302.
Liquidambar styraciflua (red gum), 341-343; not really a gum, 338, 341.
Liriodendron tulipifera (yellow poplar, or tulip-tree), 283-285; next to white pine in value among softwoods, 285.
 Live oak, 232.
 Locust. See *Robinia pseudacacia*.
 Locust, honey. See *Gleditsia triacanthos*.
 Lumber, table of amounts of, cut from various species in U. S., in 1909, 11; waste in cutting, 55; character and quality of, how affected by age and size of trees, 56.
 Lumber, pine, vast quantity of manufactured in U. S., 133.
 Lumbermen, their inaccurate use of the terms hardwood and softwood, 79, 80.
Magnolia acuminata (cucumber), 326, 327; the only species of commercial value, 326.
 Male flowers, 63, 64.
 Maple, bigleaf, 354.
 Maple, black. See *Acer nigrum*.
 Maple, broadleaf, 276. And see *Acer macrophyllum*.
 Maple, curled, 278.
 Maple, hard, 276.
 Maple, Norway, 280.
 Maple, Oregon, 276, 354.
 Maple, red, 276. And see *Acer rubrum*.
 Maple, rock. See *Acer nigrum* and *A. saccharum*.
 Maple, scarlet. See *Acer rubrum*.
 Maple, silver, 276, 280. And see *Acer saccharinum*.
 Maple, soft, 276. And see *Acer saccharinum*.
 Maple, southern hard, 48 n.
 Maple, sugar, 153. And see *Acer saccharum*.
 Maples, the, a very large family, and important as timber trees, 276; hard and soft species of, 276. See species under *Acer*.
 Mature trees. See Trees.
 Maturity in tree-life, the period of best economic development, 15.
 Medullary rays, described, 73, 74; decorative importance of, 85, 86; quarter-sawing, 86.
 "Mirrors," 74.
 Mixed stand. See Stand, mixed.
 Mockernut hickory. See *Hicoria alba*.
 Moisture, in soil, essential to tree-growth, 31, 32; trees require less of, than farm crops, 37; drying out, in seasoning, 82, 83; how maintained in nursery seed-beds, 98, 99; how supplied to young plants, 100, 101.
 Muck, best fertilizer for forest nursery, 90 n., 105.
 Muir, John, *Our National Parks*, quoted, 146, 147.
 National Conservation Commission, 58.
 Natural range. See Range.
 Natural resources, not inexhaustible, 3; need of conservation of, 3, 4.
 Nature, in reforestation, 16, 17.
 Naval stores, 134 n.
 New York Forest Nursery, 103, 104.
 Nitrogen in soil, comparative amounts of, required by trees and by crops, 36 and n.
 Norway, forests in, 9, 128.
 Nurse trees, 15, 47.
 Nursery, growing young trees in, the best method of artificial reforestation, 28-30; more expensive at first, but more economical at last, 30; in Saxony and Switzerland, 30.
 Nursery, forest, why method of growing trees in, is most successful, 87 ff.; greater size and vigor of trees so grown, 87, 88; best location of, 89; preparation of ground for, 90-92; sowing seed in, 92-97; use of screens in, 97, 98, 99; protecting

- seeds from birds in, 98; aiding germination in, 98, 99; protection from bright sunlight in, 99; care and cultivation of plants in, 100 *ff.*; abundant supply of water essential, 100; surface irrigation in, 100, 101; pulverizing surface soil in, 101; protection of seedlings in winter in, 102-104; best fertilizers for, 104-106; thinning out, 106; removal of plants from, 106, 107, 109; root-pruning in, 107, 108; "heeling-in," 108, 109.
- Nursery, transplant, defined, 89, 111; purpose of, 111; a simple affair, 113; fertilization and preparation of, 113, 114; cultivation of, 114.
- Nut-bearing trees. See Trees, nut-bearing.
- Nyssa aquatica* (tupelo gum), 340, 341.
- Nyssa sylvatica* (black gum), 339, 340; known by diverse names in different states, 339.
- Oak, black. See *Quercus velutina*.
- Oak, burr. See *Quercus macrocarpa*.
- Oak, chestnut. See *Quercus prinus*.
- Oak, chinquapin. See *Quercus acuminata*.
- Oak, cow. See *Quercus michauxii*.
- Oak, Garry. See *Quercus garryana*.
- Oak, mossycup. See *Quercus macrocarpa*.
- Oak, overcup. See *Quercus lyrata*.
- Oak, pin. See *Quercus palustris*.
- Oak, post. See *Quercus minor*.
- Oak, red. See *Quercus rubra*.
- Oak, rock. See *Quercus prinus*.
- Oak, scrub, 39.
- Oak, southern red. See *Quercus texana*.
- Oak, Spanish. See *Quercus pagodæfolia*.
- Oak, swamp white. See *Quercus platanoides* and *Q. lyrata*.
- Oak, tan. See *Quercus prinus*.
- Oak, tanbark. See *Pasania densiflora*.
- Oak, valley white. See *Quercus lobata*.
- Oak, white, 262. And see *Quercus alba*.
- Oak, yellow. See *Quercus acuminata*.
- Oak bark, tannic acid in, 75.
- Oaks, certain species of; may recur in second growth, 18; number of species in U. S., 231; division of, into classes, 231 and n., 232; species on Pacific slope, 352-354. See species under *Quercus*.
- Oaks, red, 231, 247-257.
- Oaks, white, 232, 246.
- "Oh-neh-tah," 203.
- "Oo-soo-hoo-tah," 210.
- Pacific slope, broadleaf trees of, 351-357.
- Pasania densiflora* (tanbark oak), 353; a link between oak and chestnut, 353.
- Pearlash, 278.
- Pennsylvania Forest Department; 41.
- Pennsylvania Forest Nursery, 103, 104.
- Pepperidge, 339.
- "Perfect" flowers, 63, 64.
- Phosphoric acid, in soil, comparative amount of, required by trees and by crops, 36.
- Picea canadensis* (white spruce), 182; forms great bulk of forests of Alaska and No. Canada, 182.
- Picea engelmanni* (Engelmann's spruce), 183-185.
- Picea excelsa* (Norway spruce), 185-188; an imported tree, 185.
- Picea rubens* (red spruce), 179-182; wood of, used mostly for pulp, 180, 181.
- Picea sitchensis* (tideland spruce), 178, 199.
- Pignut. See *Hicoria glabra*.
- Pine, bull. See *Pinus ponderosa*.
- Pine, cork, 140.
- Pine, Cuban, 152. And see *Pinus heterophylla*.
- Pine, Eastern white. See *Pinus strobus*.
- Pine, Georgia. See *Pinus palustris*.
- Pine, hazel, 339.
- Pine, Jeffrey. See *Pinus jeffreyi*.
- Pine, Jersey. See *Pinus virginiana*.
- Pine, loblolly. See *Pinus taeda*.
- Pine, lodgepole. See *Pinus murrayana*.
- Pine, longleaf. See *Pinus palustris*.
- Pine, northern. See *Pinus strobus*.
- Pine, Norway, 176. And see *Pinus resinosa*.
- Pine, nut. See *Pinus monophylla*.
- Pine, old-field. See *Pinus taeda*.

- Pine, Oregon, 199, 206.
 Pine, pinyon. See *Pinus monophylla*.
 Pine, pitch. See *Pinus rigida*.
 Pine, pumpkin, 140.
 Pine, red. See *Pinus resinosa*.
 Pine, Scotch. See *Pinus sylvestris*.
 Pine, scrub. See *Pinus virginiana*.
 Pine, shortleaf, 48 n. And see *Pinus echinata*.
 Pine, slash. See *Pinus heterophylla*.
 Pine, spruce. See *Pinus strobus*.
 Pine, sugar, 170, 193, 196. And see *Pinus lambertiana*.
 Pine, swamp. See *Pinus heterophylla*.
 Pine, torch. See *Pinus taeda*.
 Pine, western yellow. See *Pinus ponderosa*.
 Pine, western white. See *Pinus monticola*.
 Pine, Weymouth. See *Pinus strobus*.
 Pine, white. See *Pinus strobus*.
 Pine, yellow. See *Pinus palustris*.
 Pines, different species of, yielded one half of lumber cut in U. S. in 1909, 10, 12; importance of, from economic and industrial standpoint, 133; all species of, not equally valuable, 133; varieties indigenous in U. S., 133; all are conifers, 133; Prof. Sargent's classification of, 135.
 Pines, hard, described, 134; resin in, 134.
 Pines, pitch, in Prof. Sargent's classification, 135.
 Pines, soft, practically synonymous with white pines, 134; varieties of, 134.
 Pines, white, practically synonymous with soft pines, 134; varieties of, 134; distinction between, and yellow pines, 134. And see *Pinus lambertiana*, *P. monticola*, *P. strobus*.
 Pines, yellow, distinction between, and white pines, 134; species of, 134, 135.
Pinus echinata (shortleaf pine), 157-160; sold under many names, 157.
Pinus heterophylla (Cuban pine), 156, 157.
Pinus jeffreyi, 170 and n., 173.
Pinus lambertiana (sugar pine), 146-149; origin of its common name, 146; its enemies, 149.
Pinus monophylla, 133.
Pinus monticola (western white pine), 143-146; similarity of, to common white pine (*strobus*), 143, 144; its future, 146.
Pinus murrayana (lodgepole pine), 173-175.
Pinus palustris (longleaf pine), 150-155; known by many names, 150; its future unpromising, 155.
Pinus ponderosa (western yellow pine), 169-173; known by many names, 169; its great size, 170; 199.
Pinus resinosa (Norway pine), 166-169; *resinosa* a misnomer, 166; rapidly disappearing in U. S., 166, 167.
Pinus rigida (pitch pine), 163-166.
Pinus strobus (white, or eastern white, pine), cut of second-growth, opp. 54; cut of staminate blossoms, opp. 64; cut of seed-development, opp. 64; cut of section, opp. 72; cut of seedlings, opp. 88; cut of ten-year-old planting, opp. 136; 135-143.
Pinus sylvestris (Scotch pine), 175-177; an important timber tree in Europe, 175.
Pinus taeda (loblolly, or old-field pine), cut of section, opp. 72; 161-163; its many names, 161; varieties of, 161.
Pinus virginiana (scrub pine), 166.
 Pistillate flowers, 64.
 Pith, 73.
 Plain sawing, 86.
 Plane, oriental, 280, 328.
 Planting in hills, a method of artificial reforestation, 27, 28.
 Plants, care and cultivation of, in nursery, 100 ff.; removal of, from nursery, 106, 107, 109, 121, 122; setting in the forest, 109, 110, 121, 122; packing for shipment, 110; transplanting, 111 ff.; furnished free by states, 114; spacing, in the forest, 123 ff.
Platanus occidentalis (sycamore or buttonwood), 328-331; fungus disease of, 331.
Platanus orientalis, 280, 328.
 Pollen, 64.
 Poplar, bay, 339, 341.
 Poplar, Carolina, or cottonwood, cut of section, opp. 72; 332-337.
 Poplar, necklace, 333.

- Poplar, white, 283.
 Poplar, yellow (tulip-tree). See *Liriodendron tulipifera*.
 Poplars, and cottonwoods, confusion between, 332, 333; on Pacific slope, 351.
Populus balsamifera (balm of Gilead), 332, 334, 337.
Populus deltoides (cottonwood), 332-337.
Populus grandidentata (largetooth aspen), 332.
Populus heterophylla (swamp cottonwood), 332, 337.
Populus tremuloides (trembling aspen), 332.
 Potash, in soil, comparative amounts of, required by trees and by crops, 36 and n.
 Practical Forestry. See Forestry.
Prunus serotina (black cherry), 291-295.
 Prussia, revenue of national forests in, 18 and n.
Pseudotsuga taxifolia (Douglas fir, or Douglas spruce), 199-202; importance of, as timber tree, 199; really a "false hemlock," 199; its great size, 200.
 Pulp. See Wood-pulp.
 Pulverizing the soil retards evaporation, 101.
 Pure stand. See Stand, pure.
 Quarter-sawing, 86.
Quercus acuminata (chinquapin oak), 245, 246.
Quercus alba (white oak), 232-237; the most important of broadleaf trees, 232; methods of reproduction of, 235-237.
Quercus garryana (Garry oak), 352, 353.
Quercus lobata (valley white oak), 352.
Quercus lyrata (overcup oak), 239.
Quercus macrocarpa (burr oak), 241, 242.
Quercus michauxii (cow, or basket oak), 242-244.
Quercus minor (post oak), 244, 245.
Quercus pagodaefolia (Spanish oak), 253, 254.
Quercus palustris (pin oak), 254-256.
Quercus platanooides (swamp white oak), 238, 239.
Quercus prinus (chestnut oak), 239-241.
Quercus rubra (red oak), cut of section, opp. 72; 247-250.
Quercus texana (southern red oak), 256, 257.
Quercus tinctorium, 252.
Quercus velutina (black oak), 251, 252.
 Rain, methods of utilizing, 31.
 Rainfall, influence of forests on, 31.
 Range, botanical, 50; natural, 50.
 Redwood, may recur in second growth, 18; 199, 228-230.
 Reforestation, success of, in France and Germany, 13; the only hope of U. S., 13, 38; defined, 16; distinction between natural and artificial, 16, 17; significance of varying need of light in, 35; difficulties of, 38 ff.; four classes of land on which it must be effected, 38-41; should be begun at once where forests are being removed, 40, 41; mingling of species in, 43 ff.
 Reforestation, artificial, requires less area to be devoted to tree-growing than does natural, 18; various processes of, 22 ff.
 Reforestation, natural, effect of erosion in, 8, 9; described, 16; discussed, 17 ff.; requires larger area than artificial, 18; great uncertainties connected with, 20; Nature's method, but more likely to fail than not, 20, 21; not to be depended on, for forests of U. S., 21.
 Resin, in pines, 134 and n.; in pitch pine, 164; in Norway pine, 166.
 Respiration in tree-life, 69.
 Rings, annual. See Annual rings.
Robinia pseudacacia (locust), 319-322; the only valuable tree reasonably sure to reproduce itself by sprouts, 322.
 Root, development of, in tree-life, 65, 66; its functions, 66, 67; pruning of, 107, 108; care of, in transplanting, 109, 111, 114. And see Tap-root.
 Roumania, revenue of national forests in, 18 n.
 Russia, forests in, 9; revenue of national forests in, 18 n.; 128.
 Sap, supply of, depends on moisture,

- 31; function of, 31; circulation of, in tree-life, 67, 68 and n.; from sugar maples, 278, 279; from birches, 307, 308.
- Sapwood, formation of, 72; nature of, 73; moisture in, 82, 83.
- Sargent, Charles S., his classification of pines, 135; *Manual of the Trees of No. America*, 145, 149, 182, 199, 296, 345; *Silva of No. America*, 320.
- Sawing, various methods of, 86. And see Bastard-sawing, Flat-sawing, Plain-sawing, Quarter-sawing.
- Saxony, revenue of national forests in, 18 and n.; strip seeding in, 23; forest nurseries in, 30.
- Schlich, *Manual*, 26.
- Screens, in the nursery, 97, 98, 99.
- Seasoning, 82, 83.
- Second-growth forest. See Forest, second-growth.
- Seed, probable failure of, to produce trees under most favorable conditions, 19, 20; fertile, 63, 64; Nature's lavish method of sowing, 64, 65; sowing in nursery, 92-97 (broadcast, 93-95, in drills, 95-97); treatment of, in broadcast sowing, 94, and amount, 94, 95; how protected, 97 ff.; how sown and cared for by Nature, 115; germinating power of, not uniform, 115 n.; when and how to sow, 115-118; different classes of, 116; statistics concerning, 367.
- Seed-bed, 88, 89.
- Seed-drills. See Drills.
- Seeding, spot. See Spot seeding.
- Seeding, strip. See Strip seeding.
- Seedlings, 89; protection of, in winter, 102-104; of different species, average height attained by, in one and two years, 364, 365.
- Seeds, winged, 64, 65.
- Selective cutting, 15, 16.
- Sequoia washingtoniana* (big tree), 226-228; its great size, 227.
- Sequoia wellingtonia* (redwood), 228-230; its great size, 229; probable early exhaustion of, 229.
- Sequoias, species of, 226; the only present-day trees that existed in prehistoric times, 226.
- Shade, proper amount of, 33, 34; distinction between intolerant and tolerant trees, 35.
- Shagbark hickory. See *Hicoria ovata*.
- Shallow-rooted trees, 119.
- Shellbark hickory. See *Hicoria laciniosa*.
- Shrinkage, 83, 84.
- "Silver Sheens," 74.
- Size, at which trees should be harvested, 53 ff.
- Sod, planting trees in, 41.
- Softwood, in lumbermen's language equivalent to conifers, 79, but not to evergreens, 79; judicially determined meaning of term, 80; its meaning in this book, 80.
- Soil, products of, only resources capable of conservation, 3, 4; moisture in, essential to tree-growth, 31; utility of humus in retaining moisture in, 32, 33; do forests impoverish? 36, 37. And see Ground.
- Sowing, best time for, 114-118. And see Broadcast sowing, Nursery, and Seeds.
- Spacing trees, in the forest, 123-125; should be as uniform as possible, 124.
- Spain, revenue of national forests in, 18 n.
- Species, should they be mingled? 43 ff.; contest for supremacy between, 43, 44; pure and mixed stands, 44; principles to govern mingling of, 44, 45.
- Spot seeding, a method of artificial reforestation, 24, 25.
- Spring wood. See Wood, spring.
- Sprouts, 17, 18; reproduction of locust by, 322.
- Spruce, Douglas. See *Pseudotsuga taxifolia*.
- Spruce, Engelmann's, 193. And see *Picea engelmanni*.
- Spruce, Norway. See *Picea excelsa*.
- Spruce, red. See *Picea rubens*.
- Spruce, Rocky Mountain. See *Picea engelmanni*.
- Spruce, tideland. See *Picea sitchensis*.
- Spruce, white. See *Picea canadensis*.
- Spruce, yellow, 199.
- Spruces, the, economically important species of, 178 ff.; increased consumption of, in recent years, 178; valuable for pulp wood, 178; rapid destruction of forests in U. S., 178;

- in commerce, 179. See species under *Picea*.
- Squirrels, as seed-eaters, 149, 153, 196.
- Squirrels, Douglas, 149.
- Staminate flowers, 63, 64.
- Stand, mixed, defined, 44.
- Stand, pure, defined, 44; alleged merits and demerits of, 46.
- Stem, development of, in tree-life, 68; its struggle for light, 71.
- Stomata* (in leaf), function of, 69; must have light, 70.
- Straight-grained, 81, 82.
- Strength, determines value of wood for many purposes, 85.
- Strip seeding, a method of artificial reforestation, 22-24, 25.
- Stripped lands, 14.
- Stumpage, 129.
- Stumps, area of, at various ages, 54.
- Sudworth, George B., *Forest Trees of the Pacific Slope*, 143, 170 n., 173, 191 n., 192, 351.
- Sugar tree, 276.
- Sumac, 39.
- Summer wood. See Wood, summer.
- Sunlight, protection of seedlings from excess of, in nursery, 99.
- Sweden, revenue of national forests in, 18 n.
- Switzerland, revenue of national forests in, 18 and n.; forest nurseries in, 30.
- Sycamore, "eaty" fibre of, 77. And see *Platanus occidentalis*.
- Tamarack. See *Larix laricina*.
- Tannic acid, in bark, 75, 203, 239.
- Tannin. See Tannic acid.
- Tap-root, presence of, adverse to nursery-growth, 88; defined, 119; function of, 119; varies in different species, 119; unsuccessful attempts to deal with, 119, 120; 107, 108, 112.
- Tap-rooted trees, 119.
- Taxodium distichum* (bald cypress), 215-218.
- Texture, an element of value in wood, 85.
- Thinning-out, in forest nursery, 106; in forest, 124.
- Thuja occidentalis* (white cedar, or arborvitæ), 210-212.
- Thuja plicata* (giant arborvitæ), 210, 213, 214.
- Tilia americana* (basswood), 302-305.
- Tilia heterophylla* (white basswood), 302-305.
- Tilia pubescens* (downy basswood), 302-305.
- Timber famine, imminence of, 9, 128; not to be averted by use of species heretofore deemed of little value, 12, 13.
- Timber trees, divided into softwoods and hardwoods, 79; inaccuracy of this classification, 79.
- "Tolerant" trees, defined, 35; mingling of, with intolerant, 45.
- Transplant nursery. See Nursery, transplant.
- Transplanting young trees from the nursery, 28-30; more important for conifers than for broadleaf trees, 111, 112; proper time for, 112, 113.
- "Transplants," 89.
- Tree-culture, underlying principles of, everywhere the same, 21.
- Tree-growing, most important branch of forestry to-day, 6, 7, 13; in reforestation, 17 ff.; comparative areas required for natural and artificial methods, 18; moisture essential to, 31; in nursery, described, 87 ff.; will it ever be profitable in U. S.? 126-129; not unless economic conditions change, 126; forecast of future cost and price of products of, 127, 128, 129. And see Tree-growth.
- Tree-growth, light essential to, 35, but not in unvarying degree, 35; constituents of soil required for, in certain cases, 36; demands of, on soil, 36 and n., 37; methods of removing worthless growth from lands to be reforested, 39, 40; rate of, 41; rapidity of, to govern decision as to mingling species, 47; ratio of increase in, 54. And see Tree-growing.
- Tree-life, laws governing, 63 ff.
- Tree-planting, necessity of, 7; in treeless regions, 51, 52.
- Treeless regions of U. S., 51, 52; species of trees planted in, 51, 52.
- Trees, thirty-one species of, yielded 99.9 per cent of lumber cut in U. S. in 1909, 10, 11, 12; considerations governing removal of, in re-

- forestation, 17, 18; refuse matter from, 32, 33; all species of, require more light in old age, 36; relations between different species of, 43 ff.; should they be mingled? 43 ff.; significance of varying rate of growth in, 47, 48 and n.; selection of, for planting, 49-52; majority of, in U. S., worthless for timber, 49; natural and botanical ranges of, 51, 52; species successfully planted in treeless regions, 51, 52; when to harvest, 53 ff.; table of dimensions of, at various ages, 54; necessary use of, for fuel and farm purposes, 58 ff.; farm-lands suitable for growth of, 59, 60; may be made to assume desired form, 63; life-history of, 63 ff.; when to plant, in the forest, 121, 122; spacing, in the forest, 123 ff. And see Forest, second-growth and virgin, Forests, Nursery, Plants.
- Trees, deciduous, 66.
- Trees, immature, 15, 17, 19.
- Trees, mature, 15, 17, 19.
- Trees, nut-bearing, methods of propagating, 28.
- Trees, timber. See Timber trees.
- Trojan War, the, 260.
- Tsuga canadensis* (hemlock), 204, 205.
- Tsuga caroliniana* (Carolina hemlock), 204, 206.
- Tsuga heterophylla* (western hemlock), 205, 206; sold as Oregon pine, 205.
- "Tuck Tuck," 195.
- Tulip-tree. See *Liriodendron tulipifera*.
- Turpentine, in pines, 134 and n., 140, 155.
- Ulmus americana* (white, or gray elm), 296-299.
- Ulmus crassifolia* (cedar elm), 301.
- Ulmus pubescens* (red, or slippery elm), 299.
- Ulmus racemosa* (cork elm), 300, 301.
- United States, timber famine imminent in, 9, 10; typical of world-conditions, 9; revenue of national forests in, 18 and n.; tree-bearing and treeless regions in, 49.
- United States Forest Service, 155, 294 n., 305, 312, 346.
- Venation of leaf, 68.
- Veneers, black walnut largely used for, 314, 315.
- Virgin forest. See Forest, virgin.
- Walnut, black, 272, 292, 314, 315, 317, 318. And see *Juglans nigra*.
- Walnut, "Circassian," 339, 341, 342.
- Walnut, satin, 338, 339.
- Walnut, white, 318.
- Warping, 82, 84.
- Waste, proportion of, in cutting lumber, 55; divers kinds of, 55.
- Water, mean supply of, essential for best results, 31, 32; utility of forest floor in retaining, 32.
- Water-courses, effect of presence or absence of forests on, 8.
- Weeds, as a hindrance to tree-growth, 39, 40; eradicating, in nursery, 92, 93.
- White pine, eastern. See *Pinus strobus*.
- White pine, western. See *Pinus monticola*.
- Whitewood (tulip-tree). See *Liriodendron tulipifera*.
- "Winding" fibre, disadvantage of, 77; is it hereditary? 78.
- Winged seeds. See Seeds, winged.
- Winter, protection of seedlings in, 102-104.
- Wood, manifold uses of, 10, 12; large use of, for fuel, 12 and n., 58; chemical composition of, 37; increase of, in tree-life, 71-73; annual rings, 71; heartwood and sapwood, 72, 73; pith, 73; medullary rays, 73, 74; classification of, 79, ff.; various characteristics of, and their bearing on its value, 80-86.
- Wood, spring, 71.
- Wood, summer, 72.
- Wood ashes, unleached, 105, 106.
- Woodlot, the, 58-62.
- Wood-pulp, exportation of, prohibited in parts of Canada, 9; trees suited for, 82; value of spruces for, 178, 180.
- Württemberg, revenue of national forests in, 18 and n.
- Yellow pine, western, 193, 206. And see *Pinus ponderosa*.

The Riverside Press
CAMBRIDGE . MASSACHUSETTS
U . S . A

BOSTON PUBLIC LIBRARY



3 9999 09772 714 1

